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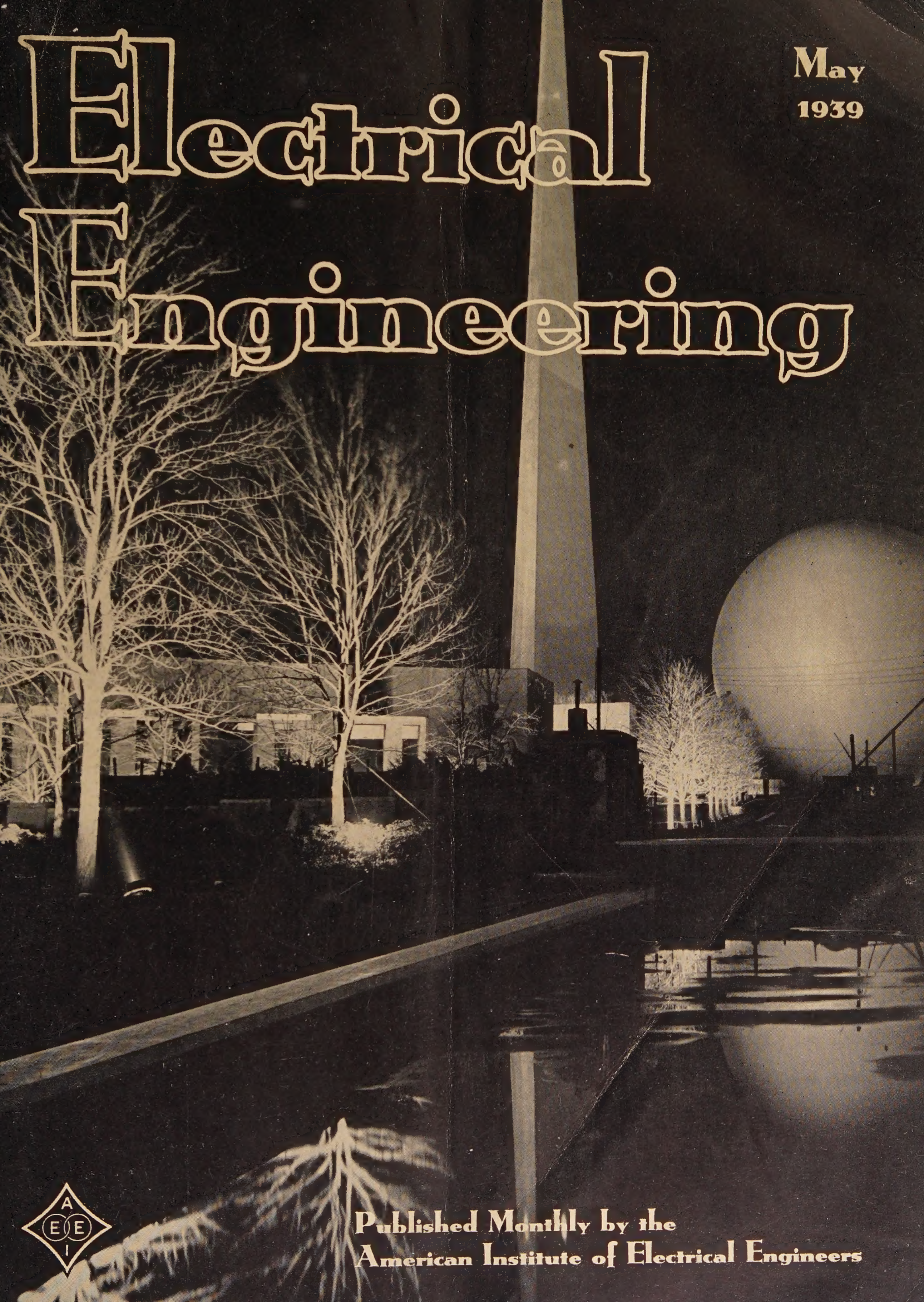

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CLIP-ON AMMETER

Electrical Engineering

Registered U. S. Patent Office

for May 1939—

The Cover: Trees on Constitution Mall at the New York World's Fair, just opened, are illuminated by 250-watt capillary mercury lamps, one unit underneath each tree. Leaves on the trees will fluoresce under the influence of the ultraviolet radiation from these lamps

Transactions Section *(Follows EE page 232)*

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High Lights

Electrochemical Industries. Statistics show that in 1936, electrochemical, electrometallurgical, and allied industries consumed some 12.5 billion kilowatt-hours of electric energy, equivalent to more than ten per cent of the total energy produced for public use during that year; with the continuing expansion of these industries and the development of new processes, this rate of power consumption is increasing (*pages 208–16*).

Enterprise and Social Progress. Aside from primitive systems, only two forms or principles of organization of human energy can be defined clearly—*enterprise* and *authority*, says a leading economist who expresses the belief that "we are now reaching a crucial stage in the process of reversion to the principle of authority, and that we shall very soon see a reassertion of social energies, and invasion of authority or government by society" (*pages 193–8*).

Compressed-Gas Insulation. Some use has been made of gases under pressure for insulating media where their properties are desirable. An investigation now has been made to obtain data for pressures as high as 600 pounds per square inch and direct potentials as high as 450 kv, which shows a possible application to cable for d-c transmission because of a definite polarity effect in concentric conductors (*Transactions pages 193–206*).

Summer Convention. June 27 has been designated AIEE day at the Golden Gate Exposition, San Francisco, Calif. To afford all those attending the AIEE combined summer and Pacific Coast convention an opportunity to visit the exposition on that day, no convention events have been scheduled for the afternoon or evening. Those planning to attend the convention are urged to make hotel reservations at once (*pages 217–19*).

Governmental Research. Scientific contributions of governmental research agencies are of high order and of distinct benefit to the public, says a leading educator who continues: "There is need for more scientific research by government to control national defense, to create new opportunities for employment, to improve the products of the farm and shop, and to raise living standards" (*pages 205–07*).

Locomotive Performance. Road tests of the new 3,600-horsepower locomotives of the New York, New Haven and Hartford Railroad illustrate the use of the reserve horsepower and overload capacity of electric locomotives to maintain fast schedules; a maximum of 7,600 horsepower may be obtained on alternating current and 5,500 on direct current (*Transactions pages 212–18*).

Crossbar Switching. A recently developed switching system for dial telephone central offices, known as the crossbar system, employs simple forms of relays and relay-type structures for all switching operations. The system of control is such that two or more attempts can be made to establish a call over alternate switches and trunks when the normally used parts are all busy (*Transactions pages 179–92*).

Capacitors. Power factor may be corrected by capacitors applied to either primary or secondary circuits, but the former is less expensive while the latter offers additional benefits. Results of an economic study indicate that secondary capacitors generally may be justified on secondary networks but have limited application on primary radial distribution systems (*Transactions pages 228–42*).

To 1939 Graduates. Engineering students in the current graduating classes may find in this issue two articles of particular interest: one offers some practical suggestions for obtaining employment (*pages 202–05*); the other discusses some of the social and economic phases of the situation facing the young engineer in this era of change (*pages 199–201*).

Magnetically Controlled Tube. Advantages claimed for a gas-filled tube using electromagnetic instead of electrostatic control for initiation of the discharge include insulation of the control circuit from the tube, operation on extremely low voltages, and lack of reaction of the tube on the impedance of the control circuit (*Transactions pages 224–8*).

News 217

Two Indexes for the Price of One. Those ordering copies of the new AIEE 17-year index, covering papers and discussions published in the TRANSACTIONS during the years 1922–38, inclusive, will receive without additional charge a copy of the last preceding index volume covering the years 1911–21 (*page 221*; *advertising page 1*).

American Engineering Council. Among items appearing in the current AEC "News Letter" are: an announcement of three committees composed of scientists and engineers to assist the President's Committee on Civil Service Improvement; and a discussion of federal relation to research (*pages 223–4*).

Bus Protection. A comprehensive survey of modern practices in bus protection, which presents data from 34 companies, indicates general acceptance of the idea of such protection, and that adequate protection may be obtained by any one of three major methods (*Transactions pages 206–12*).

Calender Drives. An adjustable-voltage system of motor drives is used in continuous processing of automobile tire fabrics, in which rubber may be either applied to the surface or worked into the fabric at production speeds as high as 35 yards per minute (*Transactions pages 218–23*).

Coming Soon. Among special articles and technical papers undergoing preparation for early publication are: an article reviewing some recent advances in electrical measuring instruments, by E. S. Lee (F'30); an article on Elihu Thomson as an electrical engineer, by D. C. Jackson (F'12); an article on highway lighting, by L. A. S. Wood (M'24); an article reviewing recent advances in electric railway signaling, by S. E. Gillespie; a paper describing relay protection for the power-supply system of the electrified division of the Pennsylvania Railroad, by E. L. Harder (A'30); papers on glass, asbestos and glass, and mica insulation, by F. W. Atkinson (M' 37), K. N. Mathes (A'36) and H. J. Stewart (A'38), and R. H. Spry (A'32), respectively; a paper discussing proposed American Standards Association transformer standards by R. T. Henry (F'33); a paper on considerations in applying ratio differential relays for bus protection by R. M. Smith (A'35), W. K. Sonnemann (A'38), and G. B. Dodds (A'29); a paper describing a rectifier for charging batteries on railroad passenger cars by C. A. Kotterman; a paper on methods of voltage control for mercury-arc rectifiers by G. R. McDonald (A'21); a paper on inductive co-ordination of telephone circuits with series highway lighting circuits for sodium-vapor lamps by H. E. Kent (M'31) and P. W. Blye (M'29); and a paper reporting a survey of the lightning performance of 110- to 165-kv transmission lines by the lightning and insulator subcommittee of the AIEE committee on power transmission and distribution.

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Enterprise and Social Progress

By VIRGIL JORDAN

The test of any form of social organization is the opportunities it creates for the release and development of human energies, declares this economist. On that basis he contrasts the principle of "enterprise," as it has operated in the United States for 150 years, with the older principle of "authority," and predicts the outcome of the struggle between them.

I PROPOSE to discuss informally, and mainly for the purpose of provoking thought, certain rather abstract ideas about the evaluation of various different principles of social organization. I do so because I think that though these ideas are important for understanding and action in connection with the economic and political problems that we face both in this country and in the world as a whole today, they are as yet largely unexplored. There has been little objective, impartial, and detached analysis in the United States of certain of the psychological or intangible elements that have underlaid the development, operation, and results of our own business system. An endless amount of literature has appeared in this country expounding in great detail the way various other economic systems—socialistic, communistic, Fascist, totalitarian, Nazi; theoretical or actually in operation in other countries—have developed, and how they work and what their results have been. Yet, in the United States where we have lived and worked in a type of economic organization in many respects unique in the world's history, we have given very little conscious attention to its real nature, the principles upon which it has developed, and the way it has operated.

At this stage nothing I can say about this whole field of problems can be considered in any way final, or even can carry much conviction, but I hope that these ideas, vague and disconnected as they may seem, may stimulate others to push thought along these lines. If any problem is important for all of us, whatever our special interests may be, it is that of evaluating the effectiveness of various types of social organization. We are confronted immediately and inescapably with the issue of making a choice among them, in the United States as in many other countries, and those choices are being dictated by the course of events, without any full understanding of the things involved in them.

I want to put out of the way at the outset two preliminary questions to which I frankly confess I have no answer, though they are fundamental. The first is whether or not people do actually choose deliberately the principle of social organization upon which they build their society or their lives. Is that choice in any sense conscious on anybody's part, or is it the product of the people's character and conditions of life? This is one of the unsolved problems of human thought, like the old one about the chicken and the egg, but there are very definite opinions about it. Perhaps the most prevalent in our time has been the Marxian point of view, so-called because it is associated with Marx's general belief that the character of the political and economic institutions in a society is determined rigidly by fundamental economic conditions. The theory of economic determinism, or the materialistic conception of human history, as expounded by Marx, is the view that people do not voluntarily determine the form of their society and the principles of their social and political organization, but that these arise out of the material conditions of their life.

My own view is noncommittal. I have no confidence in any definite answer to that question, but I do believe that it is not appropriate for human beings in any place or at any time to be fatalistic about the matter—to feel that their social destiny, the form of their institutions, is quite beyond their control, and really rests in their stomachs rather than in their brains. I prefer to think that even if it is quite futile they ought to try to do something about it anyway. So I believe that the qualities of character and the capacities of a people are the dominant or determining factors in the development of their political and social institutions, and that these qualities and capacities can certainly be influenced and developed. If this were not true our whole educational concept would be quite useless and should be abandoned. It should be noted that the socialist and communist view is in fact just the opposite, attaching supreme importance to the educational process.

The second question which I must leave up in the air is the very ancient one as to what is social progress, after all? How do we define social progress? I suppose that has been the essential subject of all philosophical speculation since the beginning of time. I recognize that almost any conception of social progress can be considered valid, for certain purposes, but I cannot consider them all, and as an economist I must confine myself to those things that fall within the proper view of the economist and his science. To him social progress must be measured by the effectiveness of a group in increasing its production of wealth—of things that it finds useful. The human or moral qualities associated with the production of wealth, all the problems of individual character involved in productive effort, are matters that do not fall within the field of economic science, and therefore must be left out of my

Address presented at the AIEE winter convention, New York, N. Y., January 25, 1939.

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consideration. This is unfortunate because they are perhaps more important for a sound and constructive evaluation of economic organizations and systems than any purely engineering considerations.

Whatever the answers to these preliminary questions, which I have mentioned merely to put aside, we all recognize that the essential problem of society can be stated this way—and it is almost an engineering statement: *to develop, release, and utilize sufficient human energy to combine enough materials and physical energy to support and defend that society.*

The utilization of human energies, natural materials, and physical forces by a group to support, defend, and expand itself is a circular or spiral process. The more that human energies are released in combining materials and physical forces to increase the support of the society, the more the available human energy will be increased. There is no end to the process, but the essential elements in it, on which I want to concentrate attention, are the human energies themselves and their maximum development and release. This is to me the most important objective or test of any principle of social organization.

The release of these energies can express itself in many ways. It must express itself first in the increase of the population, which is the arithmetical way of increasing human energies or releasing them. You must have more people if you are going to have more human energy. You must prolong human life. You must enable individuals to express or release their energies over a longer period of time, and you must open every channel of expression of human energy and of human control over materials and natural forces. In other words, the conception of the release of human energies is the opposite of the primitive belief, which still persists among a great many people, that the objective of life and of social and politicalorganization should be the greatest possible passive consumption of materials and physical forces in the form of commodities which provide human satisfaction, with the least possible creative activity on the part of the individual himself. The latter conception of the goal of social organization is becoming more and more prevalent. It contemplates a sort of return to the embryo state—to pure passive acceptance or absorption of energy and materials from the outside world, made possible by a vast industrial organization and an all-provident state which together serve as a kind of uterus for the individual citizen. In contrast the conception which I am trying to emphasize as the goal of any principle of social organization, is an active or creative one—the greatest possible release of individual human energy rather than the greatest possible absorption of satisfactions by the individual member of society.

The ways in which materials and physical forces may be combined and utilized for human purposes are governed by laws ascertained by individual human intelligence. Since nature does not recognize persons, these laws are the same for all individuals. Their application is not affected by the number or the character of the individuals who apply them. They have nothing to do with their effects on society and its problems. They would exist just the same even if there were no human beings to use them. But the ways in which human energies can be most effectively developed, released, and utilized to apply these laws are an entirely different matter. There we enter a field outside the scope of the engineering sciences. We enter an unknown territory, a dark forest, about which we have scarcely begun to understand anything scientifically.

We talk in broad terms of human energies, without really believing that we know anything about their effective release. We use the phrase merely to indicate a desire to do something of that sort rather than a belief in our ability to do it. We amuse ourselves by elaborately manipulating a lot of little statistics to measure a vague thing we call public opinion. We have "institutes of public opinion" which attempt to measure statistically the movements of this mysterious entity that is in the background of all our problems and thoughts. In England they have developed that type of activity into a new science or business called "mass observation," which is the same thing, a collection of statistical computations about what people say to somebody about something. That is the nearest approach that has been made after all these centuries to a scientific determination of the ways in which human energies move, the way in which they are released or confined, how they flow in this or that channel. Our ignorance offers opportunity for a vast amount of charlatanism in manipulating public opinion, and in experimenting in "public relations" for all kinds of trifling purposes. The great problem of determining the basic principles upon which immense amounts of human energy may be moved to this or that constructive or destructive purpose, the basis of such movement, the laws that govern it, is all unknown ground. Yet that is the essential problem of all the social sciences as distinguished from the engineering sciences.

Economics, political science, sociology are based on the movement of human energy, which we must understand and measure if we are ever to guide it effectively for economic, political, or social development. The basic question that all the social sciences have to answer is: What principles of economic and political organization tend to develop and release human group energies most effectively? There is no experimental method that can be applied to this problem. All the light that we have on it is shed by the study of history and human experience. We have to look at what human energies have done in the past, how they have moved, what seems to have influenced their movements in this or that direction, and try to deduce from the historical records some conception of underlying principles or laws.

We have about 5,000 years of recorded human history to go on, and there has been a lot of poring over that record for this purpose. After all that study, I think most social scientists, whatever their school of thought in relation to current problems, will agree that, aside from the primitive systems of which we know very little, only two forms or principles of organization of human energy can be defined clearly. They have been given many names, but I prefer to give them those which I shall use in this discussion—the principle of *enterprise* and the principle of

authority. I shall try to define and clarify these two principles of human organization.

There are very few examples of the principle of enterprise. It is questionable whether there were any before the last 150 years on this continent. Some historians say that the Greek Republic was a fair example of the application of the enterprise principle in the release of human energy, but it is a doubtful case and its examination does not teach one much. The only way we can get a clear conception of what is meant by enterprise as a principle of human organization is by contrasting it with its opposite, authority, which has been the principle most continuously applied during all the human record of which we have any real knowledge.

The contrast between these two principles is not the contrast between capitalism and socialism. Such a contrast is wholly misleading. All societies, even the most primitive of which we have any knowledge, are and must be essentially capitalistic in their economic operation. All economic progress, all elevation in the standard of living, is attained only by the use of some kind of tools, something more than man-power. Every society has to have tools if it is to survive, even if the tools are nothing more than swords, clubs, or other weapons of defense. The real questions are how the capital of a society is created, on what basis or principle it is utilized, and how effectively.

Likewise the distinction that is perhaps even more common today, between democracy and any other principle of government, is largely irrelevant. The question is not what form government or the state has, or by whom authority is exercised, but how extensively it is expressed in the social organization in comparison with the social energies of the population themselves. Relatively, all forms of government are the same, because they are essentially a restriction of human or social energies. In one way or another they are inevitably in competition with the energies of the society and the social resources.

To understand the real distinction between enterprise and authority as principles of social organization for releasing human energies, we must remind ourselves that the individual human being is an energy center, a nucleus of potential energy. From a metaphysical point of view, perhaps the individual is the only real center of energy; but that is a matter of speculation. At any rate he is a center of a type of energy that cannot be measured or comprised strictly within any of the known physical laws of conservation of energy. The human individual as an energy center seems to be one instance in which the whole can be greater than the sum of the parts, and the output greater than the input. But whatever the laws regulating that type of energy may be, we have to recognize that this individual human energy, which is the basis of all society, is in various ways heightened or diminished in its level at any time by contact with other human beings in groups. The energy level of the individual is a function of the energy level of the group and may be affected by the principle of social organization, or the influence of institutions, government policies, and "leadership" personalities, in frustrating, dissipating, or increasing the social energy.

The essential distinction between enterprise and authority in relation to the release of human energy lies in the fact that under the authority principle the social energy—that is, the energies of all the human individuals composing the group—is directed through specific channels established by some outside authority, such as the state, the church, or some representative of personal power. Thus the energies of all or most of the individuals composing the society are used to build up power for the controlling authority instead of being exercised creatively on the environment in mastering materials or physical forces or in developing the energy of society as a whole.

The authoritarian type of human organization is the oldest and most persistent, perhaps because the symbol of authority—the father, or king, or church, or government—has some magnetic power to maintain channels or lines of force by which human energies of vast masses of people may be controlled. Perhaps the reason for its potency which most frequently meets the eye in the human record is that for most of human history muscle power was the principal physical energy utilized in production, or in any kind of action by the society. The most effective way of utilizing it and combining it with materials was by regimenting masses of human beings to apply muscle power rhythmically and continuously. Hence the acquisition of slaves or wealth by conquest of other peoples, or the production of wealth through slave labor, characterized the whole economic process of society for practically 5,000 years of human history. Its basis was political ownership and control not only of human muscle energy, but also of the capital, or tools, materials, and weapons of production or conquest, because the surplus available to such a society for further production was so small and so ineffective in individual hands that it had to be aggregated and concentrated, in order to be of any use at all.

The use of man-muscle power through regimentation of its human agents in masses for conquest or for productive purposes is the basis of the authoritarian form of human organization. It is the essential principle of what we call feudalism—the oldest method of utilizing human energies in the world—the political control or ownership of property and labor. Property and labor have always been inseparable in the history of the authoritarian principle in human society. You cannot own or control all property without controlling or owning human labor, and even the human being who labors.

The development of science in the modern age made available other physical energy than muscle energy. This is its essential and most important accomplishment. It heightened the potential productive power of the individual human being, making it much greater, even on a very low level, than the productive power of the human mass utilizing muscle power. This vast release of social energy, made possible through the discovery of other kinds of physical energy which could be utilized by human beings, destroyed the intrinsic power of authority as a principle of energy development in human society. That, incidentally, is one reason why through all human history every type of authority is always opposed to the development of scientific investigation and discovery. Its

greatest enemy, the greatest force tending to weaken the principle of authority, has been the power of human knowledge.

Yet even up to the beginning of the 17th century of our history—just a few days ago, so to speak—the restrictive influence of the principle of authority upon human energy was evident all through European society, in the guild system of organization of labor and production, in the diversity of elaborate devices to maintain the *status quo* of productive groups, in the tendency for each group to seek some type of security from king or church or other authority in power. Practically the whole increase of society's wealth was in land and in gold and a trifling quantity of jewels which could be used in trade between countries. That wealth was gained by conquest, mainly, and held by the insignificant few in whom authority was vested by divine right, descent, or on some other basis. Beyond that there was only the barest subsistence for the great mass of human beings. Land, castles, cathedrals, monasteries, immense public works, armies and navies, symbolizing or expressing the power of the authority in force, were the characteristic and most important forms of wealth and production in society. The population of any particular society was increased largely by conquest, because it was worn out very rapidly through its utilization by authority as the main means of wealth production. The population of western Europe was practically stationary up to 300 years ago. It has about trebled since.

The enterprise principle, which is really the creation of modern science, and carries over the essential spirit of modern science into the field of social, economic, and political action, changed the whole panorama of human progress suddenly. Instead of the picture of the chariot, representing the principle of authority, drawn by great masses of human beings along a practically level road, there has been substituted—the only picture I can think of that represents it—a picture of an escalator, in which you have great populations ranged on the various steps, most of them at the bottom, fewer at the top, but the whole mass being raised in its standard of living through the release of the total energies of all the individuals in it, while at the same time the individuals on each of the steps have been walking upstairs through their own particular energy, and so shifting the composition of the group constantly. This has meant an unparalleled release of human energy as the center of power passed from the authority of the state to society as a whole.

The elements that accounted for that release are many, and some of them are well recognized—the use of mechanical power through steam, which was later made infinitely more elastic and flexible by electricity and oil; the whole credit mechanism, which came into existence at just about the same time as the industrial revolution; and the corporate form of enterprise. All these came into existence about the same time, enabling the pooling of individual risks of enterprise, creating many small and diversified risks instead of one large and concentrated one, providing greater flexibility in application of labor capacity and capital.

These are vital factors, but they carried with them others that are equally vital—the principle of private property; the principle of individual contract; the principles of choice of occupation and freedom of physical movement from one place to another; the principle of connecting risk and reward, loss and profit; the principle of stimulating and developing diversity of accomplishment and capacity, instead of creating the greatest possible uniformity throughout society.

All these factors and principles underlie the enterprise concept of human organization, and they all acted and interacted with one another during the so-called industrial revolution to bring about a tremendous release of human energy that overflowed the channels established by state and religious authority, and expressed itself in an unprecedented increase in the population and rise of the living standard of western Europe.

This release took effect much more in America than in Europe, where many of the old channels of flow of human energy have persisted in fossilized form, and have been very difficult to break up. The American Revolution, occurring in a new territory essentially without preexisting institutions to determine the channels of release, created an unprecedented opportunity to test the effectiveness of the enterprise principle. The American Revolution was much more than a release of human energies in the form of productive accomplishment. It was essentially an aggressive invasion and forcing back of authority almost to the point of destruction. It has been called the only real revolution in human history, for the reason that its primary object was to restrict almost to the point of annihilation the power of state authority over human energies.

It is unnecessary at this stage to emphasize again the outstanding and unparalleled nature of American accomplishment under the enterprise principle. I used the escalator simile to interpret this accomplishment, and the United States is the only country to which it can be applied. It gave the population on the steps of the social escalator, for the first time, a somewhat normal distribution—that is, a distribution according to the energies or creative capacities of the individuals.

For all of human history before there had never been anything like such a distribution of the population in economic terms. We have heard in recent years frequent use of the phrase "underprivileged classes," with great emphasis on the fact that in the United States one-third of our population is underfed, ill-clothed, or ill-housed. But a population of which only one-third is underprivileged means a population in which two-thirds is privileged. This is the first time and place in human history that there has ever existed any people among whom two-thirds could be said to have privileges of any kind. The characteristic distribution of human society up to the time of the American Revolution and the application of the enterprise principle in this country was a vast uniform mass of human beings whose status was permanently fixed, contrasted with an insignificant fraction of the total population which could be said to have some sort of privilege or position or opportunity.

Through the application of the enterprise principle in our own economic development, the per-capita income of the whole population has tripled in a single century—a rate of increase in the standard of living that has no precedent in the human record. That increase is not the only important feature of the working out of this tremendous release of human energies under the enterprise principle in the United States. The nature of wealth itself has been altered completely. For the first time, we have created in the United States a conception of wealth entirely different from that held by human society up to 300 years ago. We have a wealth that is a dynamic, fluid thing, the value of which is created solely by its effective capacity to provide useful goods and services, not by any authority. Our wealth today is productive power, not the power of authority. The things that are productive, the energies that are productive, including human energies, all enter into our conception of wealth, as contrasted with gold, land, weapons, castles, cathedrals, public works, or any of the things created for the glorification and strengthening of authority in ages past. The effectiveness of our wealth, its real value, is measured by its capacity to increase the consumptive power and productive energy of the great mass of the people, not the ruling power of the state. If it cannot do that, it ceases to be of value in our eyes. This change in the nature and conception of wealth is perhaps the greatest result of this experiment with human organization under the enterprise principle.

Today in the United States we are faced with the question of the future of this experiment. In all the rest of the world we are witnessing a reversion to the feudalistic principle of organization—authority as the basis of control of human energies. The world over, there has been what one might call a counter-revolution, a reassertion of the principle of authority as against the social energies. Here in the United States some feel that we are witnessing the beginning of a re-conquest of America by Europe, in the sense that Europe, the old breeding-ground of authority which never really came under the influence of the enterprise principle, is reasserting its influence over the character of our own social organization.

The effects of that change are not yet clear. We are living among them; we are too deeply immersed in them to be able to see them. The fact of the change, however, and the weakening of the enterprise principle both in the rest of the world and in the United States, are clear enough. We see many evidences and symptoms of it in the declining rate of increase in the population and per-capita productivity of this country. For instance, the per-capita real income produced by private enterprise in the United States is now less than it was 30 years ago, while the proportion of the national income produced or distributed by the state has enormously increased. Government in this country has distributed in money income to the American people in the last four years more than the total net product of all the business enterprise and all the individuals in the United States. The evident decline of certain types of enterprise energies, the gradual expansion of governmental activity in every field, the increasing importance of the state as an energy-absorbing agency in our society, are all indications that the balance between authority and enterprise has been somewhat altered in recent years.

The many intangible factors behind such a change would take long to discuss, and one cannot be quite sure of them. We see some suggestion of what they may be in the declining rate of population growth, evident since the beginning of the current century, and in the rapid urbanization of the population, which has made the individual increasingly dependent for support upon employment by someone else, rather than upon his own enterprise energies.

Another possible evidence of the decline of the enterprise principle is the increased amount of capital in tools and construction needed to support or to employ a single individual. Under our present economy about $10,000 worth of fixed and working capital is required to produce enough to employ—that is, support—one person, as compared with approximately half as much in the first half of the last century. That, too, has meant increased dependence of the individual upon employment, investment, and enterprise by others, rather than upon his own resources. The growth of large-scale enterprise offering employment to large numbers of people has developed in the population as a whole the concept that our industrial mechanism has become a sort of Aladdin's lamp—something that operates automatically by the use of enormous amounts of physical energy, and can provide an abundance of goods and satisfactions without corresponding exertion or release of human energies in the process. Great numbers of the human population feel more and more that they can live passively, and need not participate in production as much as they do; or, to put it quite plainly, that they need not work so much and utilize their own energies so much in order to get a living. Along with all this has undoubtedly gone an increased tendency of the typical representatives of enterprise, our industrial and business concerns, to utilize the state and to depend upon the principle of authority to increase their own power, or maintain or improve their own position in the enterprise game. That tendency has correspondingly operated to weaken the force of the enterprise energy of the individual.

The influence that has done most to break down or weaken the enterprise principle in this country was the World War, which was the most destructive event in human history, by any terms of measurement, and resulted in the greatest dissipation of human energy, of human life, and of capital, that the world has ever seen. Since the war the real energy level, not only of the United States but of the whole world, has undoubtedly been lower than it was before.

Today as we look at the accomplishments of the enterprise organization and the signs of its weakening, what attitude should we take toward the problems that face us in the future?

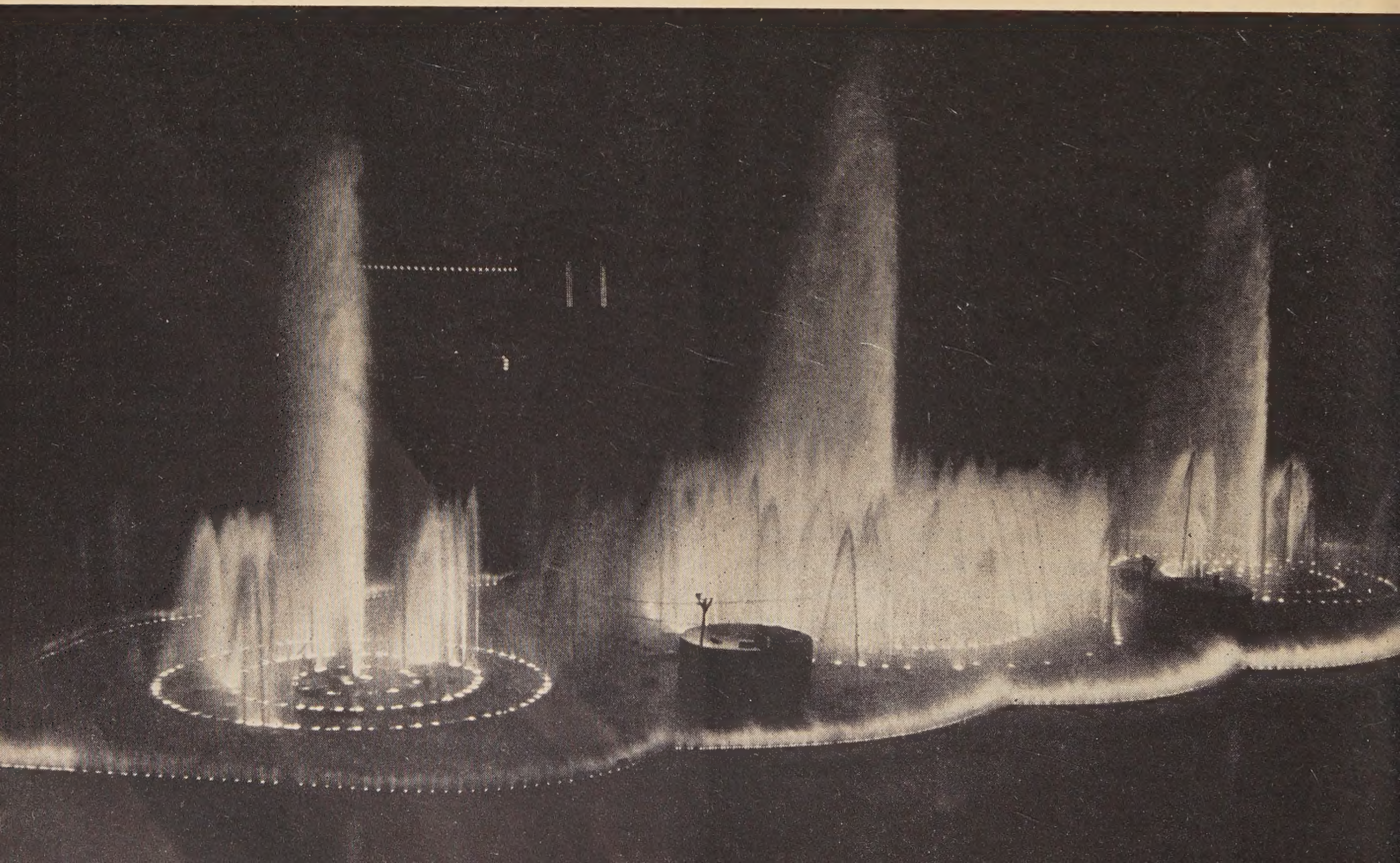
I think that in our own country, and certainly in most of the principal countries of Europe, the control of human energies and of capital—of the social resources, in short—by authority, by the state, has gone so far that the as-

sumption of ownership, both of property and of the human energies involved in its use, is an inevitable and logical consequence. In most countries there is now such complete control over the use of physical facilities and of human energy in productive activity, that there is no responsibility left for the individual owner, manager, or worker—and responsibility is only another name for the exercise of human energy by the individual.

When that stage has been reached, the actual assumption of ownership and the expropriation of the energies and the property would seem to be inevitable. We would have in essence completely reverted to the feudalistic principle of social organization, in which all property and all human energy were actually owned, as well as controlled, by an authority of some sort—state or church as the case might be. But at that stage, in the light of the whole background of modern science and its effect upon the productivity of human beings, there must be a breakdown of the effectiveness of the principle of authority. It cannot operate in the end under the conditions that have been created by modern science, and one of the principal reasons for that, I think, is that the risks are too great. When all responsibility and authority are concentrated in one agency, the risk of error is magnified almost infinitely. Under the enterprise principle, which applies human energies in diversified and flexible ways, social risks are minimized. The risk of error in our vast, complex modern social organization becomes catastrophic—too great to be borne by any single agency. The peril of breakdown of this integrated network upon which all of our society must live is so great that no agency can assume that risk. If any agency does so, it is almost certain to make an error which will destroy the whole fabric. I think we are now reaching a crucial stage in the process of reversion to the principle of authority, and that we shall very soon see a reassertion of social energies, an invasion of authority or government by society. I think groups will begin to resume for themselves functions that have been taken over by authority, and to break up large national problems into small pieces which can be managed by the social energies and resources available locally.

In this sense I am hopeful about the outlook, although I think it will be extremely difficult to make the transition to a restoration of social resources from the application of the principle of authority on such an extensive scale that it covers almost every aspect of our lives. To withdraw to a more vigorous application of the enterprise principle is going to involve strains and stresses of very serious character. But I am sure that we are going to survive them, because the development of the enterprise principle in the great American experiment has brought into the field of social action, into the utilization of social energies, a new method of such vast creative power that I doubt whether it will ever again be lost to the race.

A nightly display at the Lagoon of Nations, New York World's Fair, combines light of many colors from 585 submerged twin projectors, water rising 160 feet into the air, and music, gas flames, and pyrotechnics. A keyboard controls the combined effects. Colored lights also encircle the fountain and searchlights illuminate its jets



The Young Engineer Facing Tomorrow

By WILLIAM E. WICKENDEN
MEMBER AIEE

"Young engineers stand the shock of adjustment to the world of work better than college men in general"

TO ANY of our older engineers who may have grown pessimistic over the future, an opportunity to rub elbows with the men yet in college ought to be a reassuring experience. You are facing life in an exciting period when change is the only certainty that can be counted on. All around you are student groups caught, for the moment, in a wave of emotional radicalism, but if you are like the other 2,500 young engineers I have known and worked with these last ten years, you can be depended upon to keep your heads. As engineers you believe in change but distrust propaganda. You realize that the prevailing social scheme is not the product of design, but rather the residue of millions of trial-and-error experiments spread over ten thousand years of civilized history. What worked was retained; what failed was discarded. There is a time-lag in this rule, but it works inexorably. When a Karl Marx or an Adolf Hitler goes into silence and brings forth the blueprint of a new society, you view it with a healthy skepticism. The odds of experience are against it.

As engineers, however, we cannot remain satisfied with progress through trial and error. Our job calls on us to replace guesswork with rational planning, wherever possible. We believe in experimentation, imaginatively conceived, rationally controlled, and rigorously checked. Our interest is roused by two decades of experiment with collectivism in Russia, in Italy, in Germany, and under less coercive guises in the United States. A critical stage in these experiments seems near at hand. The result? The pendulum seems to be starting its long swing back to the ideals of freedom. If that is true, it may mean much to the seniors of 1939.

Some fruits of recent experimentation will doubtless endure. Bankers now accept the SEC instead of fighting it. Insurance men are reconciled to social security measures. The utility interests expect government to develop water power. Industry generally is lining up for collective bargaining. Sober citizens who begrudge the waste of public funds on hastily improvised projects recognize the necessity for long-planned spending on public works as a counterpoise against violent swings of the economic cycle. Collective wealth is increasing faster than private wealth. Permanent gains are being made in the conservation of soil, water, and mineral resources and in public facilities for education, health, and recreation.

Many of you may have more to do with public welfare than with private enterprise, and these new trends may largely shape your careers. A growing proportion of you will probably find careers in government service. This may be good for your profession, by making a more even balance between the individualistic practitioner and the career man and by affording a wider choice between technical and executive types of responsibility. Equally, it should be good for government, helping to even the balance between social visionaries and fact-minded men. If engineers are to take a larger part in government, it is the concern of all of us to make government a better place for engineers to work. We ought to pull together for fair compensation, for a more rational grouping of engineering functions, and for their removal from direct political pressure. This is not a remote issue; it may touch next year's bread and butter for many seniors. Honest engineering calls for clearly defined responsibility, for reasonable freedom of initiative, and for non-political tenure. Do you want your job to depend on getting the initials of the right political boss? Do you want your decisions revised in the interest of the election returns? Do you want to be caught in a mesh of red tape? Can you expect to work well in a confused, overlapping, or isolated organization?

Facing tomorrow, it is time now to stop taking the economic world for granted. It will be well for you to reckon your stake in free institutions and in free enterprise. This principle of enterprise is not something remote or abstruse. It is the inner drive which urges men to get on and not merely to hold on, to depend on their own efforts rather than the paternalism of the state. It spurs the scientist to wrestle with nature, the inventor to strive for a novel product or a new way of doing work, the thrifty man to sacrifice in order to save and to own, the financier to take the risks of a new industry, the engineer to plan, and the executive to organize for increased efficiency. What we call capitalism is the fruit of freedom and enterprise in the world of work. Free enterprise, it is pretty generally agreed, will work well only in an expanding economy. In the past, spreading frontiers, virgin resources, and rising population have supplied the expansive force. Now we have to seek it in raising the general standard of living of a population predominantly urban and industrial.

Free enterprise, when wisely directed, tries to raise

Although this address was delivered to a group of civil-engineering students, it is believed to be of interest to all young engineers; manuscipt made available by Sidney Wilmot, editor-in-chief, American Society of Civil Engineers, for simultaneous publication in *Civil Engineering* and in other society journals.

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living standards by multiplying wealth, while state paternalism almost always ends up in attempting a solution by dividing it. What happens when an attempt is made to distribute social benefits before they are produced has been all too apparent in France. Higher wages, shorter hours, paid vacations, and multiplied insurance schemes, unmatched by effort to raise the efficiency and volume of production, have served only to raise the cost of living, destroy markets, reduce employment, weaken the franc, and threaten the nation with impotence in the face of strongly organized enemies. Every engineer knows that permanent gains in wealth and leisure are the by-products of rising efficiency, and cannot be created by government subsidy; that the way to cure unemployment is to create more jobs through research, thrift, and enterprise, by developing new products, by creating new industries, and by translating technical advances into reduced prices and wider markets. One quarter of all our employment today is said to be in industries which did not exist before 1880.

In our modern industrial society we thrive not merely through what we spend for goods quickly consumed, but through what we spend to put more men to work. On the average, it costs about $7,600 today to equip a worker for his job. In the steel industry, the figure is said to be $11,500 per worker and in the electrical utility industry, $47,000. The flow of new capital into investment has all but stopped, under a public policy of policing industry rather than encouraging it, and there is little prospect of healthy recovery until it is re-established. The accumulated deficit of capital replacement and new investment of the last decade has been estimated at something like 150 billions. This is a vital matter to engineers. We spend the money which prepares jobs for men, directing it through construction and manufacturing channels into wages and purchases of materials, through which it ultimately is transformed into purchasing power for consumption goods. Engineers can thrive only when society thrives by multiplying its economic capacity.

Facing tomorrow, you are facing the risks of decision which mark off the man from the boy. Heretofore, most of those risks have been taken for you by parent, school, or teacher. You will be tempted, in the spirit of the times, to prefer security to adventure. Most of you who do so choose will settle into mediocrity. If you have not had the privilege of going away from home to college, try for a job in some other town. Finish the job of growing up, if possible, out from under the wings of the family and the college which reared you.

The engineer does not shun risks, but he takes them prudently. It will be important to you to choose a field which challenges you, but one in which you can succeed by reasonable application and effort. Success is a habit, and not a lucky break. Education comes through success, in getting a taste of achievement which creates a craving for more. Men are lured to success, not driven. If you succeed it will be because you are spurred by inner drives rather than by outside rewards.

You will begin life in a competitive struggle, but with odds in your favor. President Compton of Massachusetts Institute of Technology, reporting on a study of 54,000 officers of 500 corporations, has stated that the college man is seven times more likely than a non-college man to become such an officer, but that an engineer is thirty times more likely than a non-engineer. The advantage is great, but it is well to judge the odds in the light of changing conditions. Going to college has become a generally accepted social habit, much as going to high school became twenty-five years ago. One young person in seven enters college today. Place beside this fact another, namely, that about one family in seven is above the income level of $2,400 per year, and it is plain that college-going has about caught up with preferred opportunity in our present society.

The odds are with you, but they will not save you from the relentless sifting of the first five years out of college. The shock of passing from college, where everything conspires for your development, to a realm of repetitive work has been likened to shifting a fast-moving car from high to low gear. It is a jolt to find that you are expected to go on with work after you feel that you have exhausted its learning possibilities, to find yourself and most of those about you using so little of what you learned in college, to have a boss who pushes you on output while you have to push him if you wish to learn anything. You will find that where a hundred men will learn under the organized routine of a school, or ten under the inspiration of a voluntary group, only one will keep driving ahead under his own power.

When you discover that you must now fight your own battle for self-development, you will be tempted to work for yourself rather than your employer. You will want to be a brilliant performer and to go places in a hurry, with dreams of a vice-presidency at 30. Then some day you may awaken to the fact that too much zeal of this kind is holding you back, that you are really heading for one of those "lone worker" jobs which are blind alleys in most organizations. At this stage, a good football player is likely to hold an advantage over a brilliant scholar. To get ahead on the main track, you will have to learn to put your organization first and to adjust yourself to the tempo of group activity. You will have to get others to perform and not merely perform yourself. You will have to learn to judge men, fit them to their tasks, train them, iron out their troubles, check their performance, appraise and reward their work, and inspire them with organization spirit.

The first five years after college are usually the most critical of an engineer's career. For one who is held back by lack of knowledge, ten are stalled through inability to surmount routine. The Engineers' Council for Professional Development recognizes this as one of its major problems. Now that it has carried out so successfully the work of accrediting college curricula, its next great task is to aid its component societies in so guiding and stimulating young engineers that the curve of personal development will less frequently flatten off in this period. Within the colleges there is concern everywhere to give engineers a large share in activities which make for self-assurance, team-work, capacity, and imaginative leadership. Many of us have stuck too close to the curricular grindstone.

Educators of all sorts are observing that young engineers

stand the shock of adjustment to the world of work better than college men in general. They have a clearer sense of direction. Fewer of them flounder. They know the worth of discipline. Sustained work is no novel experience, nor does physical effort appall them. Few are troubled with conflicts of personality. They accept economic realities. Employers have long since recognized these qualities, and the depression years have emphasized the engineer's preferred position. To the seniors facing tomorrow these are grounds for self-confidence, but not for overconfidence. The make-or-break test lies just ahead. The critical question is "Can you surmount routine?" Every good college of engineering trains men for careers of decision and action. Their opportunities are boundless, but they set their own limitations of achievement.

Facsimile Broadcasting in California

REGULAR facsimile broadcasts of a morning newspaper to 100 subscribers now are being made by the McClatchy newspapers in Sacramento and Fresno, Calif. The service, which began February 2, 1939, uses standard broadcast frequency bands to transmit signals and synchronizes senders and receivers through the interconnected facilities of the Pacific Gas and Electric Company. While experiments with the equipment have been under way for several years, this is the largest regular service yet attempted and the first use of facsimile network broadcasting.

Written and set in type at the offices of the Sacramento *Bee*, the *Radio Bee* is broadcast from station KFBK there and by wire over station KMJ in Fresno, under a Federal Communications Commission order permitting radio stations 50 facsimile receivers each. An eight-page paper (page size $8^1/_2$ by 11 inches) comes from the receiver in an eight-foot strip. Over 4,000 words in 10-point type can be transmitted in an hour.

The signals which cause a printer mechanism to reproduce printed matter (pictures or text) are produced by a mechanical-photo-electric scanning equipment, the output of which modulates a standard broadcast transmitter. The signal is amplified upon reception to actuate a printer bar magnetically. Paper and carbon paper are held between the printer bar and a helix rotating at 75 rpm, so that the point of intersection of helix and bar moves in a straight line across the paper as the helix rotates. When a signal causes the bar to move, a black dot is printed at the point of intersection. As a line is completed the paper has moved forward $^1/_{125}$ of an inch, and the next line is printed.

Operation is synchronized by means of synchronous motors on an interconnected a-c system. Correlation within a line is achieved by "automatic framing." A signal is sent from the broadcasting station before each line is printed, and if the receiver is not in correct position, the synchronous motor is caused to slip, the operation being repeated until framing is correct. This process, which occupies several minutes, takes place when the time-controlled receivers are first turned on, in the early hours of the morning. Within three hours the paper is completely printed and ready to be torn off the receiver.

Since the mechanisms are simple and may be serviced during the part of the day when they are not in use, low cost is possible. At present the sets are not for public sale and no fees are paid by subscribers. The equipment is that of the C. J. Young system, announced last year by RCA and being demonstrated at the San Francisco Golden Gate Exposition.

Engineering Schools and Engineering Industries*

NO engineer can contemplate the whole field of his profession without the thrill of recognizing the leadership of science—the new knowledge which is remaking the physical world. But most of the achievements of science require the services of the engineer, whose care it is to translate facts into physical form for the use of society.

To teach what the facts of nature are and particularly how to apply them to social purposes is the function of the engineering school. It is obvious that if it taught only the facts without the application, its students would be scientists and not engineers. The art of applying science requires as much study as science itself but is exercised in a different realm, one peopled with men and women rather than facts and principles, concerned with social rather than natural laws, and revealed through the whole group of studies known as the humanities.

Certain qualities of character, as well as of mind, are essential to the successful practice of the engineering profession, because all engineering is ultimately involved in some way with industry. There the factors of labor, capital, and management meet those of science, with results which are changing the physical world. Partly because of his new knowledge, and partly on account of the methods of thought in which he has been trained, the engineer has come to fill in industry a broader place than engineering alone. He has become important in the function of management, occupying a pivotal position, intermediate between capital and labor and competent to understand the problems of both.

For this reason, students and public are best served by those engineering schools which, looking ahead to industrial responsibilities for their graduates, supply more than mere technical training. With these aims, however, the school must keep pace with the industrial changes going on around it. Only when teachers have opportunities to co-ordinate industrial experience with scientific study can an engineering school offer to industry men properly oriented to meet its demands today.

* Abstracted from an address of the same title delivered by Gano Dunn (A'91, F'12) president of the J. G. White Engineering Corporation and of Cooper Union, at the annual luncheon of the Alumni Federation of Columbia University, New York, N. Y., February 13, 1939.

Suggestions on Seeking Employment

By CHARLES F. DALZIEL
ASSOCIATE AIEE

Some practical suggestions that may aid the engineering graduate in becoming situated in industry

WE HAVE all listened to representatives from industry discuss the timely subject of seeking employment. I think that you will agree with me that in general these discussions have been unintentionally or deliberately biased in favor of a specific company, or a particular field of interest. I have listened to varied presentations of the subject, and have had occasion to discuss the subject with many graduating senior students at the University of California during the last seven years. Since I represent neither an employer nor the unemployed, I shall attempt to discuss the general situation of finding employment from an entirely unprejudiced standpoint.

The first point to be mentioned is that industry desires and employs *college graduates*. Doctor Karl T Compton, president of the Massachusetts Institute of Technology, made a study of 54,000 officers of some 500 typical industries (Education and Business Leadership, *EE, February 1938, p. 77*). The results showed not only that college graduates have a much better chance of advancement in industry than non-graduates, but also that engineering graduates are actually 30 times as likely as graduates of non-engineering courses to achieve positions of responsibility. He found that the college man was 7 times more likely than a non-college man to become an official.

It is apparent that industry seeks the technically trained college graduate, as evidenced both by this study and common knowledge. It is implied that effort expended in getting a technical education is worth while from an educational standpoint, and also the best known investment. The next consideration is to inquire what industry desires to find in the college trained man. The prospective employer is probably looking for:

1. The enthusiasm of youth, tempered with intelligence.
2. A willingness to do hard and dirty work.
3. A healthy body, the best insurance for uninterrupted output.
4. A sense of humor and a likable personality.
5. General knowledge based on a well-rounded education.
6. A trained mind with sufficient knowledge to permit productive work in some field of industry.

Often an enginering graduate is disappointed after an interview in which the prospective employer fails to quiz him on technical points, and asks such questions as: "Who won the World's Series?" or "Who played in the Rose Bowl last year?" Apparently the employer was attempting to determine the applicant's general knowledge. He was satisfied that the man's technical training had been sufficient; after all, he was a technical graduate from a recognized school of learning.

I knew of a girl who applied for a teaching position in one of our large cities. She was being interviewed by members of the board of education. The eldest, some 80 years of age, asked if she liked modern dancing. She replied that she did, fearful of how this might react on the representative of the older generation. He replied, "Will you demonstate a few of the steps of the Big Apple for me?" Quick as a flash she replied, "I will be glad to, if you will be my partner." She was found capable of handling a difficult situation tactfully, and had a sense of humor. She was offered the position.

Methods of Attack

There are almost as many suggested solutions to the problem of finding employment as there are applicants. Any method of attack that works is a correct one. Perhaps the problem can best be discussed by asking and answering questions. Let us proceed along this line.

Question: Should you use "pull" in locating a job?

Answer: Certainly, use all the "pull" you can muster. You may be hired because of it, but it is self-evident that you will have to rise on your own merits if you are going to get along with your fellow workers and be happy in your employment.

Question: If your pull fails to materialize, a common experience, what are the next best avenues of approach?

Answer: Four methods suggest themselves:

First choice: college interviews. When an employer goes to the time, expense, and trouble of contacting colleges and interviewing college men, he is there for one purpose only, that of finding the best man for his job. He wants to hire a man, and he wants to meet and talk with you. He has made it his business to find out if you are the right man for his needs. Do not hesitate because you may not be at the top of your class. Because of your particular experience, interest, or personality, you may be tops with him. Put your best foot forward, strike while the iron is hot, and land the job, if you can.

Second choice: your father's associates. Don't forget that your father is your most reliable friend. Discuss the problem with your parents, and with your father's business associates. Have your father mention your name to his

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Based upon a paper presented at the Mu Chapter, Eta Kappa Nu, employment seminar, Berkley, Calif., March 30, 1939.

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friends, and make every attempt to meet them personally. Accept all invitations for interviews, keep all appointments on time, and show a lively interest even though the prospect may not at first appear to be in your particular field of interest. Many a position has failed to materialize because a friend who had agreed to see what he could do was allowed to lose interest. Remember that both your father and his associates are glad and willing to help not only just any deserving young man but especially you.

Third choice: technical employment agencies. The Engineering Societies Employment Service is maintained for the members (including student members) of the national societies of civil, mining, mechanical, and electrical engineers, in co-operation with four other allied organizations. It is a non-profit co-operative enterprise, and publishes a weekly bulletin listing men available and engineering positions open. Offices are maintained in San Francisco, Chicago, and New York City. The cost is a percentage of the first month's, or the first year's salary, payable after you have been employed. Members of the associated societies should try to visit the nearest office and discuss their problems with the experienced men managing this service.

There are also other technical and non-technical employment agencies which may be consulted. They are probably most valuable to persons having practical experience in addition to a good education; however, many young college men find employment in this way. This opportunity should not be passed over lightly, certainly not without first making inquiry.

Fourth choice: personal interviews. Make a systematic survey of firms doing the type of work in which you are particularly interested. Call at the head office and state that you have a personal matter to discuss with Mr. —, the chief engineer. If he is out, ask for an appointment. If the firm is located at some distance, write a letter requesting an appointment for an interview. State that you are a recent college graduate and desire to discuss the general possibilities for young men in their particular field of activity. Never ask for an application blank. To ask outright for a job is to invite a curt letter: "*In reply to your recent communication, kindly be advised that there are no vacancies at the present time, and we anticipate none in the immediate future.*"

The Engineering Approach

Systematic research on the job question requires time, patience, and ingenuity. Attack the problem as you would any engineering task. Sit down and think out various approaches. Try them all. Keep carbon copies of all your letters, and study the replies, comparing the results of the various strategies employed. Constantly strive to improve your letters from the standpoints of grammar, forcefulness, tact, and style. The temper of the successive replies gives a measure of your accomplishment.

It is difficult to obtain the names and exact addresses of the best men to contact. Some possible sources of information are the Buyers' Reference Number of *Electrical World;* such buyers' guides as MacRae's Blue Book, Sweet's Catalogue Files, ASME Mechanical Catalog, Chemical Engineering Catalog; the classified telephone directory of your city. In looking for a position in the West, you may find helpful the April 1939 issue of *Electrical West*, which contained a directory of the western offices and representatives of electrical manufacturers doing business in that area. Those interested in government positions will find names, titles, and addresses in the Official Register of the United States: Directory of Federal and State Departments and Agencies, published for each state, and also in various state registers and directories. These may be found in most large libraries. Inquire at the document division.

References

The subject of references brings to mind this simple interview. *Prospective employer:* "Have you any references?" *Applicant:* "Surely, here is a letter, '*To whom it may concern: This man worked for us for one week and we are satisfied.*' "

I suggest that you prepare a list of men who know you and think enough of you to write letters on your behalf. Discuss the situation with each one of them, and get their consent before giving their names as references. Keep a record of the number of times you give each name. Obviously, to give the same list of references repeatedly will lead eventually to boring letters of recommendation.

Application Blanks

The problem of references and personal history should not be left to the last minute. To sit and ponder over an application blank in some prospective employer's office while trying to recall exact dates of past employment, the date of your birth, your mother's maiden name, and other data, is likely to make a very poor impression. This can be avoided by a carefully compiled personal history or biography. List all past employment, full- and part-time. Be sure to include the first name or initials, title, and correct address of your immediate superior for each employment listed. Part-time work which helped to pay your way through college should be included—it indicates your determination to get ahead in spite of adverse circumstances. Select a good recent snapshot of yourself and have several copies made. Sign and date each picture at the bottom to identify them if they should become detached and lost from subsequent application blanks. In other words, start your personal file, and keep a permanent record of the important events in your life.

Personal Appearance

For a moment place yourself in the position of a man interviewing laborers for ditch-digging. Would you employ a man who called at your office in formal dress and had a wishy-washy handshake? The answer is "no!" You would hire a man who appeared in the clothes of his calling and who shook hands like a man. Apply

the same principle to yourself. You have passed the college boy stage. You are a gentleman, seeking a place in industry along with other gentlemen. This calls for a hair cut, a shoe shine, and the substitution of a good business suit and a freshly laundered shirt for the college corduroys. Do not overdress. Overdressing makes as bad an impression as being slovenly.

Never seek an interview when you are depressed and feel that there is no hope left, for the simple reason that emotions are reflected in facial contours, voice, and spirit. When you feel discouraged over your failure to find work, take the day off, and force yourself to postpone further consideration of the subject for the present. Start with the thought that history repeats itself, and countless young men before you have found positions to their liking. If this does not produce an optimistic trend of thought, go to the nearest library and read Rudyard Kipling's "If."

Selecting an Employer

I am often asked to compare the opportunities of the large company with those of the small concern. I think relative size is unimportant in itself. The more important consideration is the comparative financial position of the companies in question. Compare their records in some reliable financial guide, such as Moody, Poor, or Fitch. Check the ratings given to the bonds, debentures, and stocks. Note the number of times interest was earned for bonds, and the earnings per share for stocks. Compare the earnings per share with recent stock dividends. This study will indicate both the relative condition of the companies and the latest trends of the business. Each individual must work out his own conclusions, but the following are submitted for consideration. For completeness, a discussion of working for the government is also included.

A. Prosperous Large Company

1. Probably low pay at the start.

2. Possibility of a new man's getting stuck on a routine job, or getting lost in a remote district.

3. Broad experience in a limited field.

4. Room at the top. There are many executive and semi-official positions that pay very well.

5. Large companies generally handle many lines. Through diversification the business is stable and depression resistant.

B. Prosperous Small Company

1. Probably good pay at the start.

2. Possibility of keeping moving and growing up with the company.

3. Limited experience in a broad field.

4. Executive jobs are few, and pay moderately. You may find that you will have to attend several funerals before there is a place for you at the top.

5. Small companies are generally very responsive to business conditions. The characteristic response is described by the phrase "either a feast or a famine."

C. Company in Financial Trouble

1. Probably fair pay at the start.

2. Promotions frozen.

3. You may find a spirit of discontent or sabotage prevalent.

4. Since you were among the last men hired, any slump in business is an excuse for letting you out. You may feel that you have no security, and you may be looking for a new position at a most unfavorable time.

D. Working for the Government

1. Best pay at the start.

2. First few promotions automatic, but later promotions tend to be frozen.

3. Your position may turn out to be a political football.

4. Stable and depression proof.

With reference to working for the government, it might be well to state that a great many thoughtful men think the salvation of our present form of government depends very largely upon the election and employment of honest, technically trained college graduates. It is indeed unfortunate that this field is overworked by one class and to some extent underrated by those capable of rendering the highest type of service.

Teaching

A few remarks regarding teaching as a profession may be in order. There are always opportunities for a limited number of young college graduates as assistants, particularly in laboratory courses. It is the writer's opinion that these positions should be considered temporary financial aids, or subsidies, for the purpose of obtaining higher degrees. To accept such a position as permanent, especially when there is no opportunity to work toward a higher degree, will probably result in disappointment. There is a growing and justifiable demand that the important positions in the educational field be filled by persons having advanced degrees or a very considerable amount of practical experience, preferably both. For such persons teaching provides a rare opportunity for service in training youth, and occasionally the satisfaction of making original contributions to technological progress and civilization. Those qualified will find the remuneration adequate, although possibly slightly below that obtainable in industry during normal times.

The following remarks, although not pertinent to the immediate problem of finding employment, are so closely related that they should be included. In this country you have the right to say and do what you please within much wider limits than are permitted anywhere else in the world. We all admire the man who acts in accordance with his convictions. However, remember that your employer had his share of trouble in keeping his employees working in harmony before you became a member of the organization. Regardless of the merits of your case, if he finds that you are causing an increase in restlessness, he is likely to have his own cure for the upstart problem. You will do well to forget the majority of your grievances, and let time temper the rest. In a relatively short time you will be considered a seasoned and respected employee, and at the psychological moment you will find your immediate superior sympathetic and willing to discuss your troubles in the privacy of his office.

The following axioms are given in conclusion:

1. Never change positions unless you can do so at a gain in salary or social prestige, preferably both.

2. Eradicate from your memory the words to the graduating hymn, "WPA, here we come."

The fact that the present business recession is beginning to be accepted as a new normal prompts the suggestion that you accept the first technical position offered. Put your whole heart and energy into it with a solid determination to make good. You will soon find that you have put so much of yourself into your job that you have manufactured a keen interest in it. Make friends with colleagues, subordinates, and immediate superiors. Find out what they think of their prospects. Grin and bear it, and stick it out for about six months. If, after you have your own prospects fairly well estimated, you come to the conclusion that there is no future in this concern for you, remember that you were looking for work when you accepted the position. In the meantime you have gained three important advantages:

1. You have had some worth-while experience with both men and machines, and your bargaining power has been increased by this experience.

2. It is often easier to secure a new position when you are employed.

3. If nothing else, you do not have to accept the next offer in order to maintain regular eating habits.

The Federal Government and Research

By A. A. POTTER

Some 10,000 persons are employed in Government research work, the expenditure for which was $124,000,000 in 1937

INDUSTRIES that have made the most spectacular growth during the past 25 years are also foremost in research. American industrial laboratories employ 25,000 research workers and spend $100,000,000 a year for research in order to develop new methods, new machinery, and improved materials. Some industries appropriate two to four per cent of their gross income for research. Research is an integral part of any organization interested in efficiency, in long-range goals, and in linking the present with the future. Bankers are recognizing that the research program of an industry is a safe guide to the investment value of its securities.

From the earliest days of our national history the United States Government has conducted investigation, of a greater or lesser scientific character, in order to establish a sound basis for its legislative and administrative activities. Congress is not only a creator of research agencies, but is itself engaged, through its committees, in investigations mainly in the social-science field. The Federal Government has assumed responsibility for research with special reference to agriculture, national defense, the conservation of natural resources, and the development and maintenance of physical standards.

Research by the Federal Government comprises investigations in both the natural and social sciences, and their applications, including the collection, compilation, and analysis of statistical, mapping, and other data which may result in new knowledge.

The National Resources Committee, with the approval of the President of the United States of America, has made a survey of the relation of the Federal Government to research, and published its findings in December 1938, in a report entitled "Research—A National Resource." This article is mainly a review of that report.

During 1936–37 the United States Government expended 120 million dollars for research, or about one dollar per capita of its population; 70 million dollars were derived from general funds and 50 million from emergency funds. For 1937 the research expenditure was 124 million dollars, of which 54 million were derived from emergency funds. Government research expenditures in the social-science field have increased materially and involve about one-quarter of the regular funds and nearly all of the emergency research funds. One-half of one per cent of the federal budget is the average amount spent for research.

Investigations in agriculture predominate among the fields of governmental research with more than one-third of all the regular research funds devoted to agriculture, an increase of $2^1/_2$ times in 15 years. Next to agriculture comes research for improved military and naval equipment and techniques, which account for about one-fifth of the regular research expenditure. Aeronautical research represents one-eighth.

About 125 federal bureaus and independent agencies are engaged in some form of research and about the same

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number carry on no research. The list of government-research projects is large, but includes mainly the fields of agriculture, defense, weather interpretation, public health, physical and biological problems inherent in the public domain or federal possessions, mental health, crime control, life and culture of the American people, physical and biological research involved in international relations, population changes, economic indices, labor problems, standards of living, governmental finance, and determination of standards.

Constitutional Responsibility

The Federal Government is obligated to carry on research in fields in which there is a constitutional responsibility, such as national defense and the determination of standards; fields in which the Government performs essential regulatory functions, such as control of traffic in foods and drugs and supervision of power production; fields in which extensive administrative or construction functions have become a federal responsibility, as in flood control and highway construction; fields in which the major problems are of a definitely national or interstate character, like agriculture, weather forecasting, and fisheries; and fields of research that lead to new products for which there is no market, except in war time, and no incentive for private industry, except to the extent that it is federally subsidized.

The Federal Government is also better equipped to carry on research that is very costly, such as aeronautic research, investigations and surveys in geology, geodesy, mineral technology, public health, and soil conservation.

The authority, prestige, and resources of the Federal Government may be used to organize and direct research in any given field on a national scale. Agricultural research, for example, is co-ordinated through state experiment stations. The War and Navy departments keep continuously informed as to developments in industry. The National Advisory Committee for Aeronautics, through its laboratory, serves as a central research plant for both industry and government alike.

The work of state agricultural experiment stations is an example of effective decentralized research stimulated by and carried on in close co-operation with government. The Public Health Service maintains relations with medical schools and with state boards of health.

During the Civil War, the National Academy of Sciences was chartered to make available to the government the talents of the scientific men of the country. During the World War, the National Research Council was organized to supplement the National Academy of Sciences in bringing to the government the services of the nation's research workers in natural science, anthropology, and psychology. The division of cultural relation of the Department of State is intended to bring about intellectual co-operation between this and other countries.

Progress demands new standards, new kinds of measurement, and ever-increasing accuracy. The Bureau of Standards performs these functions for the benefit of industry, the Government, and the public at large.

The numerous activities of the Department of Agriculture have grown up invariably in response to demands from farmers for assistance in solving practical problems that could not be handled by individual effort. Agriculture is a major industry which is nationwide in scope. The Department of Agriculture is the largest single research organization in the world and is the center of agricultural research. Through field laboratories, grants-in-aid, extension activities, and co-operative relations with federal, state, and private agencies, the department in a measure directs all research work in agriculture. There are 7,500 research workers in the department and in state agricultural experiment stations who are active in improving agriculture. Each state receives a grant of $90,000 for agricultural research in addition to its proportionate share under the Bankhead-Jones Act of 1935, which will reach three million dollars by 1940. States more than match federal grants for agricultural research.

The basic act for agricultural research is the statute creating the Department of Agriculture in 1862 and setting it up as a research agency. The creation in 1884 of the Bureau of Animal Industry extends this function. Then follows the Hatch Act, 1887, extending federal support to states for agricultural research. The Adams Act of 1906 allows additional agricultural research funds. The most recent legislation is the Bankhead-Jones Act of 1935, which is an amendment to the Land-Grant College Act "to conduct research into laws and principles underlying basic problems of agriculture in its broadest aspects."

The Forest Research Act, or the McSweeney-McNary Act, of 1928, is intended to encourage forestry research.

A closely knit, highly centralized form of organization is typified by the Navy Department. All its activities are pointed toward the single end of national defense. National defense requires constant research to develop new weapons and improved materials of war.

The National Advisory Committee for Aeronautics was created by Congress in 1915 and is mainly a research agency. It has the largest and best equipped aeronautical research laboratory in the world at Langley Field, Va. Leading foreign countries have sent aeronautical missions to this country to study NACA research organization and laboratories.

The Geological Survey is the largest contributor to geological science, and the results of its findings are of value to the mining and petroleum industries, as well as to those concerned with the construction of highways, bridges, water storage, and similar works. River flow and investigations of wells are within the field of the Geological Survey.

The Bureau of Mines is national in scope in its relation to mining and metallurgy. It grew out of the Geological Survey and is intended to carry on scientific and technological investigations in mining.

The Coast and Geodetic Survey maps coast lines, investigates tides and currents, and makes geodetic control surveys on which surveying and mapping operations depend.

Governmental research has acted in many cases as a

stimulus to industry; examples of this are nitrate fertilizer research by the Bureau of Chemistry and Soils, boiler scaling and embrittlement of boiler steels by the Bureau of Mines, and the new industries that have grown out of the work of the Bureau of Fisheries on oil and fish-liver oils. The Navy Department has been an important factor in developing the steel industry through its insistence on steel plates for battleships as early as 1883. Steel castings were first made in this country in 1887 to meet Navy requirements.

The Social Security Board is expected to carry on investigations in the fields of old-age pensions, unemployment, accident compensation, and the like.

Regulatory Commissions Sponsor Research

Regulatory commissions, which have as their primary functions regulation rather than research, sponsor research as an important activity. Thus, the Interstate Commerce Commission has authority to "inquire into the management of the business of all common carriers." The Federal Trade Commission is empowered to "investigate the organization, business conduct, practices, and management of any corporation engaged in commerce. Its activities encompass foreign countries as well as the United States.

The National Bituminous Coal Commission is expected "to conduct research designed to improve methods used in the mining, preparation, conservation, distribution, and utilization of coal, and the discovery of new uses for coal."

The fields of research open to the Federal Power Commission, Bituminous Coal Commission, Maritime Commission, Federal Communications Commission, and other agencies are as fully specified as are those of the Bureau of Reclamation, Rural Electrification Administration, Vocational Educational Board, and the Civilian Vocational Rehabilitation Board.

The Tennessee Valley Authority is authorized to undertake "experiments for the purpose of enabling that corporation to furnish nitrogen products for military purpose and for agricultural purposes." Other research agencies are the Federal Housing Administration, Federal Reserve Board, Bureau of Census, Bureau of Foreign and Domestic Commerce, and the Tariff Commission.

The Bureau of Census furnishes social-science data and carries on social-science research of great value to the public. The Congressional Library aids the collection and interpretation of research information.

About 10,000 persons are employed in research positions with the Government. In 1896 only about 2.3 per cent of the civilian positions in executive civil services involved professional, scientific, and technical functions as contrasted with 12.7 per cent in January 1937. From 1931 to 1937 social-science research workers under civil-service classification have increased 17.28 per cent as compared with 9.31 per cent in the physical sciences. The recruiting, placement, and in-service training of research workers in the Government are not as satisfactory as in industry or higher educational institutions. Most of the investigators in the Government bureaus are selected from civil-service lists and at salaries of $2,000 to $9,000 per year. The present civil-service procedure places the Government at a disadvantage in recruiting and in holding the highest type of scientific and technological personnel in competition with industry, universities, or other scientific agencies. The Government, in most bureaus, fails to train its promising young research workers in newly developed techniques.

The bureaus and agencies of Government have the privilege of going outside the civil service for the employment of experts in a consulting capacity or to investigate special problems. The compensation of such experts varies from $10 per day in the Bureau of Mines to $50 per day in the Bureau of Reclamation. Advisory committees, such as the visitors of the Naval Observatory or the visiting committee of the Bureau of Standards, serve without pay.

Any consideration of the relation of the Federal Government to research is incomplete without some mention of what is done by colleges and universities, particularly those supported by public funds. All research agencies, including the Government, must rely upon higher educational institutions for research personnel and for leadership in pure research. In 1867 only 25 universities conferred doctor of philosophy degrees, and 44 such degrees were conferred that year; 2,709 were conferred by 86 institutions of higher learning in 1937. One-quarter to one-third of those who receive the doctor of philosophy degree continue in research.

A large part of the research in universities is independent and unorganized, controlled directly or chiefly by the interests of the individual professor. Of the 1,450 American colleges and universities, 150 expended for all purposes during the year 1935–36 about 265 million dollars, and of this about 50 millions were spent for research. The remaining 1,300 spent a total of 155 million dollars and about 1 million for research.

About one-quarter of the income of 20 leading universities is claimed to be spent for research. Those spending more than 2 million dollars per year are: California, Chicago, Columbia, Harvard, Illinois, and Michigan; $1^1/_2$ to 2 million: Cornell, Minnesota, Wisconsin, and Yale; 1 to $1^1/_2$ million: Massachusetts Institute of Technology, New York University, Ohio State University, and University of Pennsylvania; $^1/_2$ to 1 million: Purdue University, Iowa State College, Iowa University, Pennsylvania State College, Texas Agricultural and Mechanical College. In many of the institutions the agricultural-experiment-station funds aid in making the totals appear conspicuous. In most land-grant colleges and universities little research, outside of agricultural research, is done.

An unbiased analysis of the research activities of our Government leads one to conclude that the scientific contributions of the 125 bureaus and independent agencies are of high order and of distinct benefit to agriculture, national defense, and the public at large. There is need for more scientific research by government to control national defense, to create new opportunities for employment, to improve the products of the farm and shop, and to raise living standards.

Power Requirements in Electrochemical, Electrometallurgical, and Allied Industries

Electrochemical and electrothermal processes consume electric power in such large amounts as to warrant special consideration with respect to the supply of electric energy produced to meet the growing needs of the United States. This presentation summarizes the past and present use of electric power in the electroprocessing industries, and considers the probable effect of economic trends and the development of new processes and products upon their future power requirements

ELECTROCHEMICAL and electrothermal processes, separately or integrated with other operations, play a large part in the manufacture of products that touch the daily life of every individual. Some of these products can be obtained by no practical means except electric power; others are perfected or improved or given special characteristics by electric processing. Some are classed as strategic materials, essential for the national defense. Some are in common use; others assist or make possible the manufacture of important commodities.

The investigations upon which data here contained are based covered the more important industries and processes using electric power primarily for electrolysis or for heat. The electrolytic group includes the production of aluminum, copper, zinc, magnesium, cadmium, and certain other metals; and of chlorine, caustic soda, and hydrogen peroxide. The electrothermal or heat group includes the application of electric furnaces to the melting, refining, alloying, and heat-treating of iron and steel, brass, and ferroalloys; the manufacture of abrasives, refractories, calcium carbide, carbon products, and phosphoric acid. The processes for chemical nitrogen, potash, and inorganic fertilizers were included in the study because they are related to various electrochemical operations and are of similar significance to the development of power markets and power resources.

Information on the consumption and supply of electric power was compiled largely from statements by the industries and by electric utilities, supplemented where necessary by estimates based on various published and unpublished data. Some of the figures on the capacity of power equipment installed were supplied by manufacturers of equipment. The period covered, in general, is 1926 to 1936.

Location of the Industries

Electrolytic and electrothermal plants for the most part are located where hydroelectric energy is available in quantity at low cost. Representative of this are the large establishments at Niagara Falls and Massena, N. Y., Keokuk, Iowa, Sault Ste. Marie, Mich., Alcoa, Tenn., Badin, N. C., and Tacoma, Wash. Among the exceptions are the arc and resistor furnaces for iron and steel, located according to product requirements; and the electrolytic copper refineries on the Atlantic seaboard, which are near the large markets for copper in the brass and electrical industries of New England and the Middle Atlantic states, and also convenient for the refining in bond of foreign ores and concentrates received by water.

Figure 1 shows the location of the major electrolytic industries in the United States. Widespread but individually small operations in electroplating, electrotyping, the electrolytic production of hydrogen and oxygen, and the electrolytic production of chlorates are not shown, because these processes are parts of other and larger industries and have as yet been of relatively little significance to power.

The electrothermal processes cannot adequately be presented in a single map. Figure 2 shows the location of the direct and indirect arc furnaces for melting and refining iron and steel. The installations are grouped according to industrial districts and include 571 units having an aggregate capacity of 805,667 kva. A striking fact revealed by this map is that the equipment is not concentrated in iron and steel centers alone, but is widely distributed wherever machinery, tools, and motors are made. No fewer than 21 localities contain electric-furnace capacity of 10,000 kva or more.

Figure 3 shows the electric-furnace ferroalloy industry of the United States. The effect of available low-cost electric power may be noted particularly in the locations of plants at Niagara Falls, N. Y., Keokuk, Iowa, and Alloy, W. Va.

The installations of induction furnaces are shown in the listings of table I. Relatively small both in tons capacity and rated kilowatts, these furnaces are of growing importance to the brass and alloy steel industry.

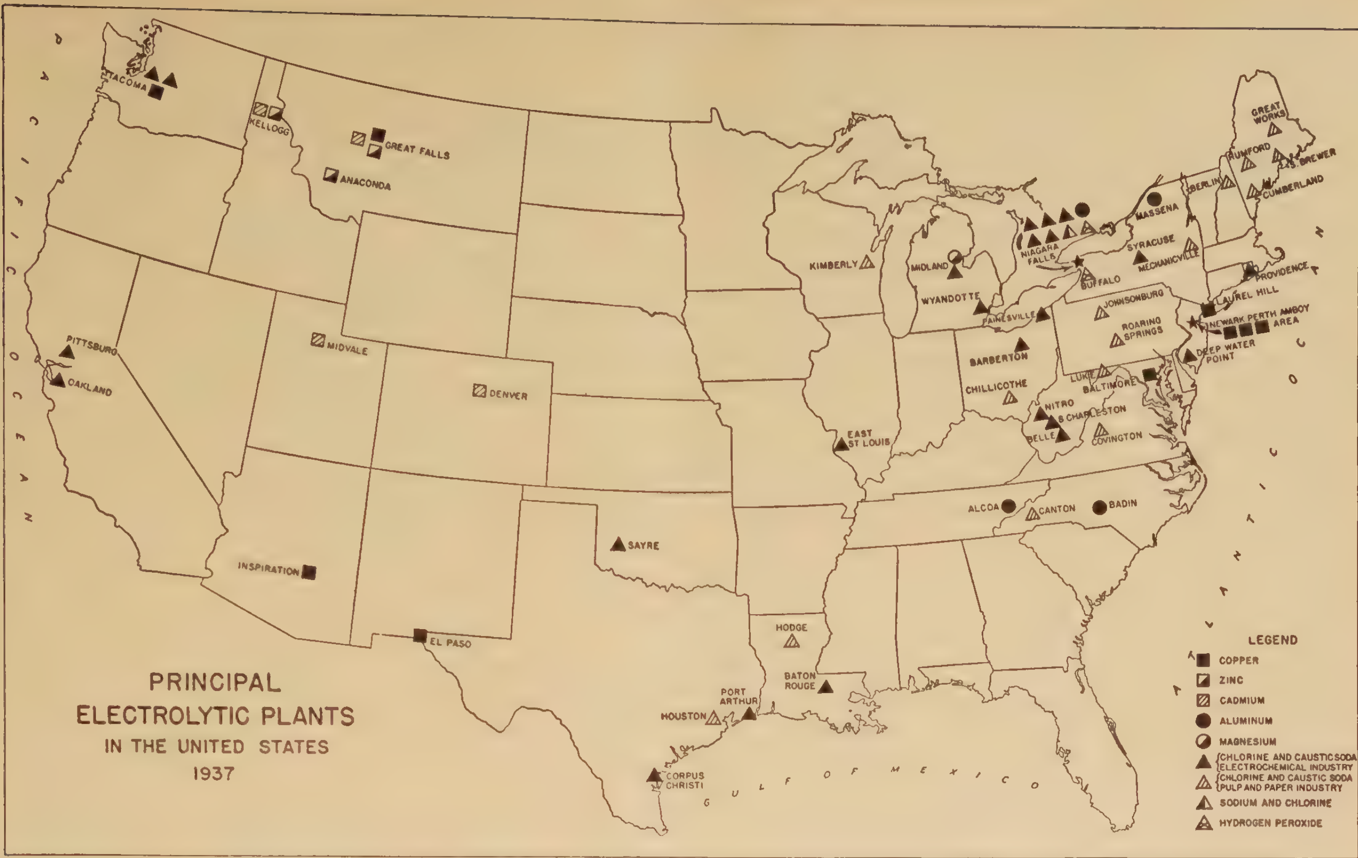
Power Requirements and Supply

Energy Consumption

In 1936 the products and processes covered by this report consumed about 12,500,000,000 kilowatt-hours of electric energy, equivalent to more than ten per cent of the total energy generated for public use in the same year. This figure for the year 1936 includes 105,000,000 kilowatt-hours for electric-furnace iron, 2,200,000,000 kilowatt-hours for electric heat treating, and 600,000,000 for miscellaneous small operations on which adequate data

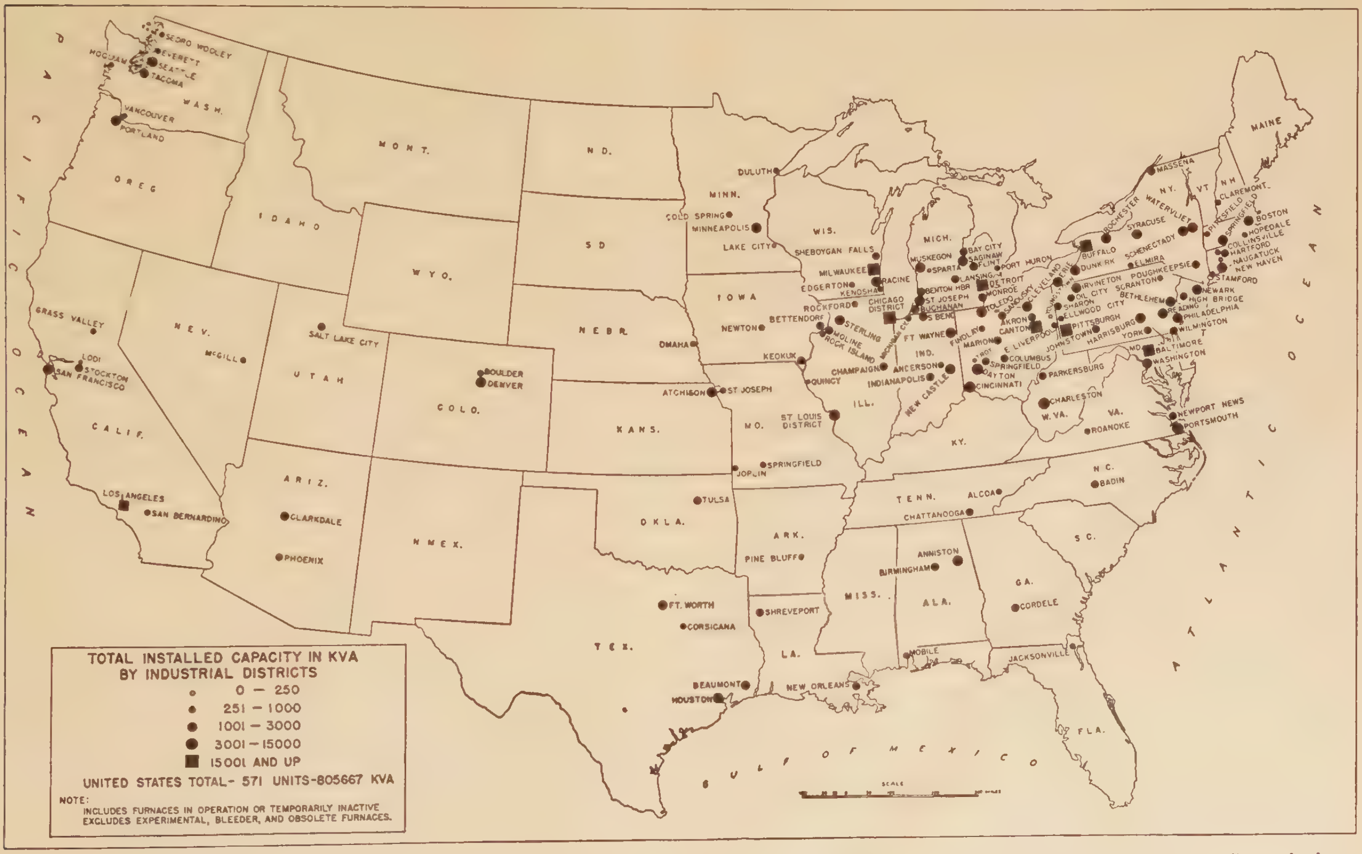
Abstract of the report of the same title published by the Federal Power Commission September 1938. The discussion follows closely an address delivered by JAMES V. ALFRIEND, JR. (A'33) at the AIEE summer convention, Washington, D. C., June 24, 1938.

1. For all numbered references, see list at the end of the article.



—*Federal Power Commission.*

Figure 1. Location of the principal electrolytic plants in the United States, 1937



—*Federal Power Commission.*

Figure 2. Location and capacity of electric arc furnaces for melting iron and steel, United States, 1937

for previous years could not be obtained.* Without these operations, the total for the industries on which reasonably complete information could be obtained was 9,609,141,000 kilowatt-hours of energy in 1936. For these industries the figures for the period 1926–36 are shown in table II. As may be seen, the 1936 total exceeded the previous peak of 1929 by more than 623,000,000 kilowatt-hours.

Table III shows figures for the segregation of energy consumed for separate products during 1936. Aluminum, chlorine, and ferroalloys required more than one-half of the total. The relation of 1936 to 1929 is shown in table III, column 6, and graphically illustrated in figure 4. The over-all ratio is 107 per cent, as compared with 88 per cent for the Federal Reserve System index of general manufacturing activity. Attention is drawn to the very large increases shown for cadmium, magnesium, and chlorine.

Energy Supply

Figures for energy supply can be stated for certain plants whose reported energy consumption totaled 4,588,726,000 kilowatt-hours in 1936, out of the total of 12,500,000,000 kilowatt-hours. Of the reported energy consumption, 2,669,788,000 kilowatt-hours was generated in 1936 with equipment owned by the reporting companies, and most of this was accounted for by the aluminum industry, which has installed a large amount of hydroelectric capacity in order to obtain its large requirements for power at low cost. Future increases in generation are to be expected in aluminum and also from new hydroelectric capacity for the production of ferroalloys near Charleston, W. Va.

Connected Load

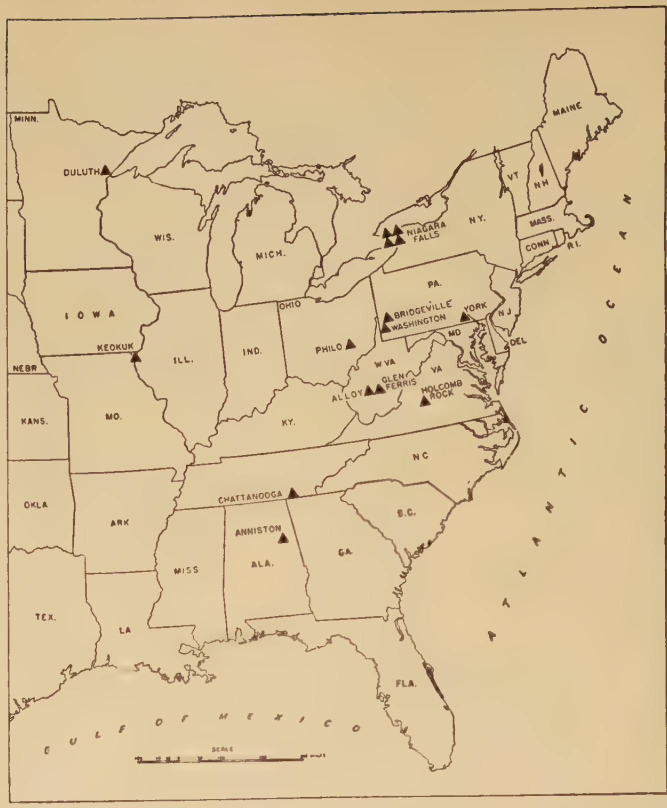
The combined connected load of the industries and processes included in this report is equivalent to more than 3.8 million kilowatts—a figure whose relative magnitude may be gauged by comparing it with the total generating capacity of all the public utility systems in the country, 33.7 million kilowatts. (Privately owned electric utilities, 31,458,003 kw; municipally owned electric utilities, 2,225,986 kw; total, 33,683,989 kw.)[1] Table IV summarizes the capacity of the equipment for the several industries considered.

A significant recent development is the appearance of the mercury-arc rectifier for the conversion of alternating current to the direct current required for electrolysis. Such equipment has been employed for some years in electric-traction service and in d-c distribution systems, and experimentally for high-voltage d-c transmission. The first unit for electrolytic service in the United States was installed in 1934, following an earlier installation at an electrolytic zinc plant in Canada. The rapid increase to a total of 136,460 kw completed or on order in July 1937, indicates that this type of conversion equipment has advanced beyond the trial stage. The successful performance of the pioneer units at 500 to 600 volts may lead to a considerable change in the design of electrolytic substations, because at the higher voltages the new equipment saves floor space and foundation work and provides better efficiency. The two units in the chlorine industry that can be connected to supply direct current at 1,000 volts and the recent units in Canada for 830 volts indicate that further advances are to be tried.

Another noteworthy development is the use of the electric-arc furnace for the production of elemental phosphorus, phosphoric acid, and phosphates. When the Tennessee Valley Authority began its investigation, there were but two such plants in the country, one at Niagara Falls and one at Anniston, Ala. Today there are seven plants (including the Tennessee Valley Authority) having 19 furnaces of an aggregate capacity of 102,000 kva. Contracts by the Monsanto Chemical Company and the Victor Chemical Company provide for the supply of energy for later additions of about 66,000 kva to this electric-furnace capacity.

Characteristics of the Loads

The load characteristics of these highly specialized processes are very different from those of other industrial operations. There are three general types: the electrolytic loads, which are inherently continuous and almost uniform; the arc-furnace loads, which are subject to interruption and also to wide and sometimes violent fluctuations in demand; and the resistor-furnace loads, which are typically steady during the hours of operation. The electrolytic and resistor-furnace processes are



—Federal Power Commission.

Figure 3. Electric furnace ferroalloy industry, United States, 1937

* Electroplating, electrotyping, the production of chlorates, electrolytic oxidation, and reduction processes applied to organic chemicals, and miscellaneous electric-furnace operations. Individually these loads have been relatively small and they are distributed so widely as to place the collection of data beyond the scope of this investigation. The total consumption of energy in these operations is estimated roughly at 600,000,000 kilowatt-hours in 1936.

highly desirable from the viewpoint of the supplying utility. For the arc furnace, special control methods and arrangements of feeder circuits have been devised to keep the demand fluctuations within bounds and make it possible for the central station to supply the furnace load without undue interference with the regulation of service to other customers.

The electrolytic demand can be varied intentionally between certain limits by adjusting the voltage of the d-c supply, without materially affecting the efficiency of the cells. It is thus possible either to operate at a nearly uniform demand or to obtain other characteristics if desired. Advantage is being taken of these possibilities at the large copper refinery whose load curve for a typical day is reproduced in figure 5. The controllable electrolytic demand is utilized to smooth out the uncontrolled and varying demands of the other plant operations, thus obtaining a better over-all load factor and a lower average price for power for the plant as a whole. At this refinery the control equipment is actuated automatically by the combined plant demand. One of the larger producers of electrolytic chlorine has also installed automatic control for the same purpose.[8] Another copper refinery obtains somewhat similar results by manual control.

The possibility of utilizing large quantities of low-cost seasonal or "secondary" power[†] is suggested by such examples of load control and also by electric furnace operations at Keokuk, Iowa, and near Sheffield, Ala., where arrangements have been made for the use of secondary power at low rates for a portion of their requirements. The plants having such contracts produce ferroalloys, calcium carbide, or phosphates.

A further characteristic of the electrochemical and many of the electrothermal loads that may assist in fitting their requirements to available low-cost power is that they are typically made up of sequences of comparatively small equipment units whose output is not limited by other plant operations. Small-capacity plants may therefore show production costs not very different from larger ones, and in general the operations are more flexible and the rates of output can be varied with smaller losses in efficiency and less interference with operating schedules than in most large industries.[¶]

Table I. Electric Induction Furnaces in the United States, 1936–37

State	For Melting Brass and Other Nonferrous Metals and Alloys, January 1, 1936			For Melting or Heating Stainless Steels and Other Special Ferrous Alloys[a] January 1, 1937		
	Number of Furnaces	Capacity: Pounds Charged	Capacity: Rated Kilowatts[b]	Number of Furnaces	Capacity: Pounds Charged	Capacity: Rated Kilowatts[b]
Connecticut	276	217,550	18,365			
Delaware	2	1,500	120			
District of Columbia	1	750	60	8	5,050	500
Illinois	40	30,000	2,595	2	16,000	1,200
Indiana	1	100	60	1	100	60
Kentucky	17	12,750	1,035			
Maryland	6	4,500	360			
Massachusetts	6	4,500	390	7	16,050	900
Michigan	49	42,050	3,405	6	2,000	510
New Jersey	22	21,400	1,480	17	15,900	1,650
New York	44	33,600	2,970	7	3,900	570
Ohio	11	12,450	1,055	12	13,300	2,125
Pennsylvania	12	10,850	945	23	16,542	2,500
Rhode Island	2	300	100	3	960	150
Wisconsin	25	18,750	1,515	1	100	60
Total	514	411,050	34,455	87	89,902	10,225

a. Includes three installations also melting brass.

b. Brass furnaces are rated according to individual units; steel and heating furnaces according to the capacities of the motor generators supplying each installation or group of furnaces.

Cost of Power Related to Price of Product

In the electroprocess industries with their enormous power requirements, the cost of electric power is necessarily a high proportion of the price of the resulting products. For this reason the industries have sought and found locations where power could be generated or purchased cheaply.

Table V shows the relation of the cost of electric energy to recently prevailing prices or values for some of these products, at assumed energy rates ranging from one mill to one cent per kilowatt-hour. Where available, actual average energy rates known to have been paid by representative producers are given. In considering these actual rates it should be noted that average unit costs of generated energy and average unit prices of purchased energy differ according to the location and also according to the quantity and characteristics of use in any one plant.

Taking electrolytic zinc as an example, 0.25 and 0.5 cent are shown as representative average rates which have been paid by producers in the field. At 0.25 cent, the cost of power is about 9.3 per cent of the selling price of the zinc. At 0.5 cent it is 18.6 per cent.

In most cases the typical price paid for electric energy happens to result in a ratio of energy cost not far from ten per cent of the product price or value. Rates providing a lower ratio than this are naturally acceptable to the industry, but successful commercial practice indicates that so far they have not been absolutely necessary. Lower rates would presumably encourage more extensive development; with some exceptions, higher rates have apparently prevented any development.

In general these ratios of energy cost to product value are several times as large as in other manufacturing industries, where the power cost is often about two per cent. But other factors must be considered, including the cost of raw materials and labor, transportation and marketing facilities, and especially the value of the electric process in reducing other costs and in obtaining co-products or by-products. Power is relatively so important in the aluminum industry, for example, that the reduction plants have been established in regions where energy can be generated at a cost of less than three mills per

† Power that is usually available but is not guaranteed as "firm" power. At some hydroelectric plants the firm output is governed by water conditions that occur only occasionally and can be predicted with some accuracy in advance, as for example by low water for a few weeks of an extremely dry season; and there are large quantities which are available at all other times but can not be guaranteed.

¶ The possibility of adjusting industrial operations to fluctuating hydroelectric output, instead of supplying steam-electric generating capacity, was discussed in Electrothermic Hydro-nomics, by R. J. Gaudy, *Transactions of The Electrochemical Society*, volume 70, 1936, pages 171–84.

kilowatt-hour; on the other hand, electrolytic copper-refining plants with their smaller power requirements have purchased energy at average rates as high as 1.5 cents per kilowatt-hour. Plants in the ferroalloy industry purchase energy at three or five mills per kilowatt-hour

Table II. Energy Consumed in Thousands of Kilowatt-Hours[a]

Year	Total	Electrolytic	Electrothermal	Motors and Lighting[b]
1926	4,121,080	2,546,454	703,095	871,531
1927	6,781,959	3,407,228	2,342,685	1,032,046
1928	5,090,556	3,306,636	834,141	949,779
1929	8,985,978	4,436,458	2,957,186	1,592,334
1930	7,236,431	4,048,060	1,861,206	1,327,165
1931	5,748,807	3,109,246	1,605,397	1,034,164
1932	3,400,979	1,943,715	703,093	754,171
1933	4,501,059	2,230,327	1,399,762	870,970
1934	4,738,858	2,111,445	1,377,757	1,249,656
1935	6,973,387	2,919,527	2,446,161	1,607,699
1936	9,609,141	4,359,683	3,312,833	1,936,625

a. Does not include chlorine, 1926 and 1928; brass, etc., 1926 to 1933, inclusive; calcium carbide, 1926–28–30–32–34; electric furnace iron, all years; electric heat treating, all years.

b. Includes total requirements for chemical nitrogen, potash, and inorganic fertilizers.

and still their power cost is 21.3 to 44.3 per cent of the product value; electroprocessing is here used for product characteristics unobtainable by other means.

Product and Process Competition

Direct competition exists between electric furnaces and fuel-fired furnaces for many purposes, affected in some regions by the availability of raw materials and the accessibility of markets. Each type of equipment has its most suitable applications. In some operations the technical or operating advantages of the electric equipment outweigh the extra cost; in others, cost is the primary consideration. Where economy governs, future developments will depend on comparative prices of fuel and electric power.

In the copper industry, electrolytic refining and reduction for years has accounted for 90 per cent of the domestic production of primary refined copper, and no change in this relationship is in sight. In the production of pure zinc the electrolytic reduction process experienced a rapid growth and then apparently stabilized at about one-fourth of the domestic total; the remainder is produced in fuel-fired retorts. With the increasing demand for high-purity zinc in brass and die castings and the recent introduction of electrogalvanizing, and with decreasing electric rates, a resumption in the growth of the electrolytic zinc process is expected.

In the melting of brass for rolling and casting, electric induction and arc furnaces have already largely superseded fuel-fired equipment. In the large and important field of heat-treating, the capacity of electric furnace equipment has increased from 12,000 kw in 1920 to 770,773 in 1937. The electric equipment possesses definite advantages in accuracy of temperature adjustment, adaptability to modern "line" production, and the possibility of controlling the gases within the furnace. The success of "bright annealing" and continuous annealing illustrates the effect of these special technical advantages. Electric resistor furnaces have displaced many fuel-fired furnaces for these purposes, in spite of higher first costs and relatively high operating costs. With the present downward trend in equipment cost made possible by better design and better materials, and progressive rate reductions made possible by lowered electric costs and improved load characteristics, it appears reasonable to expect a continued increase in installations of electric heat-treating equipment.

In several relationships in the marketing of electroprocess products, competition has definitely increased the consumption of electric energy required for one or both of the competing materials. For example, aluminum has made considerable progress as a material for electric

Table III. Consumption of Electric Energy in Electrochemical, Electrometallurgical, and Allied Industries, United States, 1936[a]

Principal Product	Consumption of Electric Energy (Thousands of Kilowatt-Hours): Total	Process: Electrochemical	Process: Electrothermal	Motor and Lighting	Ratio of Total (2) 1936 to 1929 (Per Cent)
(1)	(2)	(3)	(4)	(5)	(6)
Electrolytic:					
Aluminum[b]	2,597,000	2,217,367	0	379,633	93.0
Copper[c]	651,317	282,856	633	367,828	61.1
Zinc	514,895	445,876	0	69,019	83.0
Cadmium	3,916	3,275	0	641	148.1
Magnesium	39,033	35,130	0	3,903	429.7
Chlorine and caustic soda[d]	1,568,415	1,375,179	0	193,236	149.5
Electrothermal:					
Electric furnace steel[e]	743,000	0	743,000	e	96.5
Electric furnace ferro-alloys	1,752,000	0	1,668,571	83,429	126.0
Brass and other non-ferrous alloys[f]	415,835	0	149,466	266,369	g
Artificial abrasives	87,357	0	65,489	21,868	89.0
Calcium carbide	550,000	0	523,810	26,190	77.5
Carbon and graphite products	195,663	0	161,864	33,799	181.1
Allied Products:					
Nitrogen	288,000	0	0	288,000	138.5
Potash	83,710	0	0	83,710	378.5
Fertilizer	119,000	0	0	119,000	85.0
Total	9,609,141	4,359,683	3,312,833	1,936,625	106.9

a. Figures for 1936 from Table I, Consumption of Electrical Energy in Electrotechnical, Electrometallurgical, and Allied Industries, United States, 1926–36, Section 1, Power Requirements in Electrochemical, Electrometallurgical, and Allied Industries, Federal Power Commission, 1938. Data are partly estimated.

b. Includes mining of domestic ore, production of primary ingot from domestic and imported ore, and fabrication of both imported and domestic ingot, sheet, etc. Includes estimates covering the small proportion consumed in fabricating plants operated by companies not associated with the major producer.

c. Includes energy used in associated mining, milling, and smelting activities of one company in Montana and one in Arizona. Consumption includes energy used in the production of gold, silver, copper oxide, white lead, white metals, and other metallic pigments, tin products, solder metal, arsenic, acid, phosphate fertilizers, and other products not separately reported.

d. Includes caustic potash, metallic sodium, electrolytic soda ash, and hydrogen peroxide.

e. Small amounts of energy for motor and lighting loads associated with these operations are neglected.

f. Includes melting, founding, or fabricating copper, brass, or bronze.

g. Data are not available.

transmission lines—a field previously occupied exclusively by copper. But copper is used in the electric equipment required for producing aluminum, and also in transformers and other facilities at each end of an aluminum transmission line. Opinions differ as to which material is best suited for the various types of line, but it is clear that advantage will be taken of the special characteristics of each metal and that they will assist each other in serving the electric needs of the country. Among the results will be a larger consumption of electric energy in the production, refining, and fabrication of the two metals than would be required for copper alone.

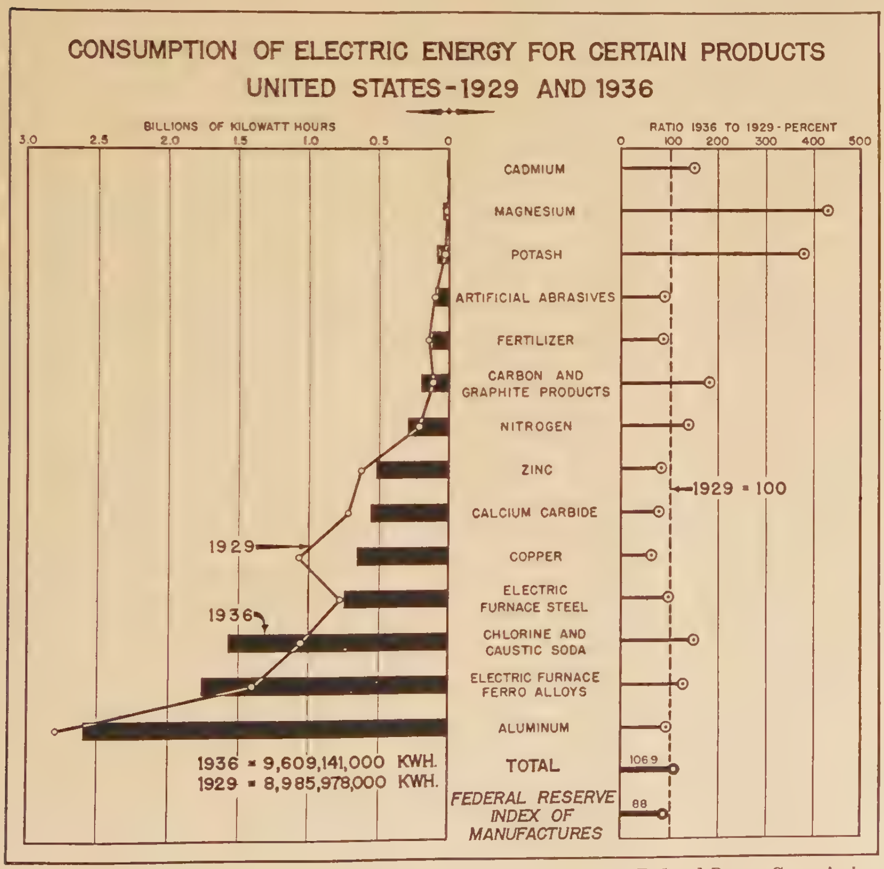
Electric-arc welding supplied an important stimulus to the fabrication of structures and machinery by welding instead of by the assembling of riveted parts of castings. As a result the use of acetylene for welding and flame-cutting has also greatly increased, in spite of the active competition of the electric welding equipment. Acetylene is made from calcium carbide, an electric-furnace product. Probably neither electric welding nor acetylene welding could have reached its present development without the other, and electric energy is a requirement of both.

High-speed light-weight transportation equipment on rail and highway, in the air, and on the water is employing aluminum, magnesium, and high-alloy steels.§ All three are products of electroprocesses. Aluminum and magnesium provide light weight by reason of their low densities; alloy steels, such as stainless steels, furnish light weight because their strength and resistance to corrosion permit the use of thinner sections. In these applications, the three types of material have been competing in a developing field, but the effect has been to stimulate keener commercial and technical rivalry rather than to limit the growth of any of the several products. All three types may be expected to be combined in light-weight equipment and structures, each in its most suitable application, with the results of better construction, an improved market for the metals, and also greater requirements for electric energy in their production.

Electroprocess Equipment as an Industrial Tool

The electrolytic cell and the electric furnace, pot, or oven are adaptable to either large-scale or small-scale operations. In addition to the large units required for the basic operations of the electroprocess industries, such equipment is being widely applied as a tool or auxiliary in other industries. Installations range from the solder pot of a few hundred watts in capacity to the electric arc furnace of 20,000 kva.

Examples of these applications are the electroplating operations of large electrical and automobile manufacturing establishments; electric furnaces and ovens in mills and foundries for iron, steel, brass, and other metals; the electrolytic cleaning of sheet metal in the same plants; and the electrolytic production of organic chemicals. The future development of such uses of electroprocess equipment as a tool in other industries may bring increases in energy requirements as great as the corresponding increases in the electroprocess industries themselves.



—*Federal Power Commission.*

Figure 4. Electroprocess industries consumed more energy in 1936 than in 1929, and showed a higher ratio of increase than general manufacturing (compare table III)

New Processes and Products

The electrochemical and electrometallurgical industries have been marked by constant change throughout their relatively brief history. Research workers have found these fields extremely fruitful and have steadily added to the list of products and processes that contribute to modern needs and affect the consumption of electric energy. These developments are continuing on a broader base.

During the past eight years research has produced striking results in the field of powder metallurgy and in the production of rare and minor metals in electric furnaces and electrolytic cells. The need for high-speed cut-

§ Railroads in the United States have placed in service 78 cars built largely of aluminum alloys, 79 cars largely of stainless steel, and 36 of other alloy steels, operating in more than 40 trains described as streamlined, high-speed, etc. R. L. Kimball, based on data published in *Railway Age*, November 1934 through June 1937.

Table IV. Capacity of Installed Power Equipment

Generating equipment:[a]	
Hydroelectric	583,400 kw
Steam-electric	227,994 kw
Internal combustion	2,005 kw
Total	813,399 kw
D-c equipment for electrolysis:	
Rotating conversion equipment	644,875 kw
Mercury-arc rectifiers	136,460 kw
D-c generators[b]	107,795 kw
Total, d-c equipment	889,130 kw
Electric furnace equipment:	
Arc resistance and induction furnaces	1,493,077 kva
Resistor furnaces and ovens	770,773 kw
Mechanical drive equipment (other than generators):	
Electric motors	951,148 hp
Steam engines and turbines	60,499 hp
Internal combustion engines	200 hp
Total, mechanical drive	1,011,847 hp

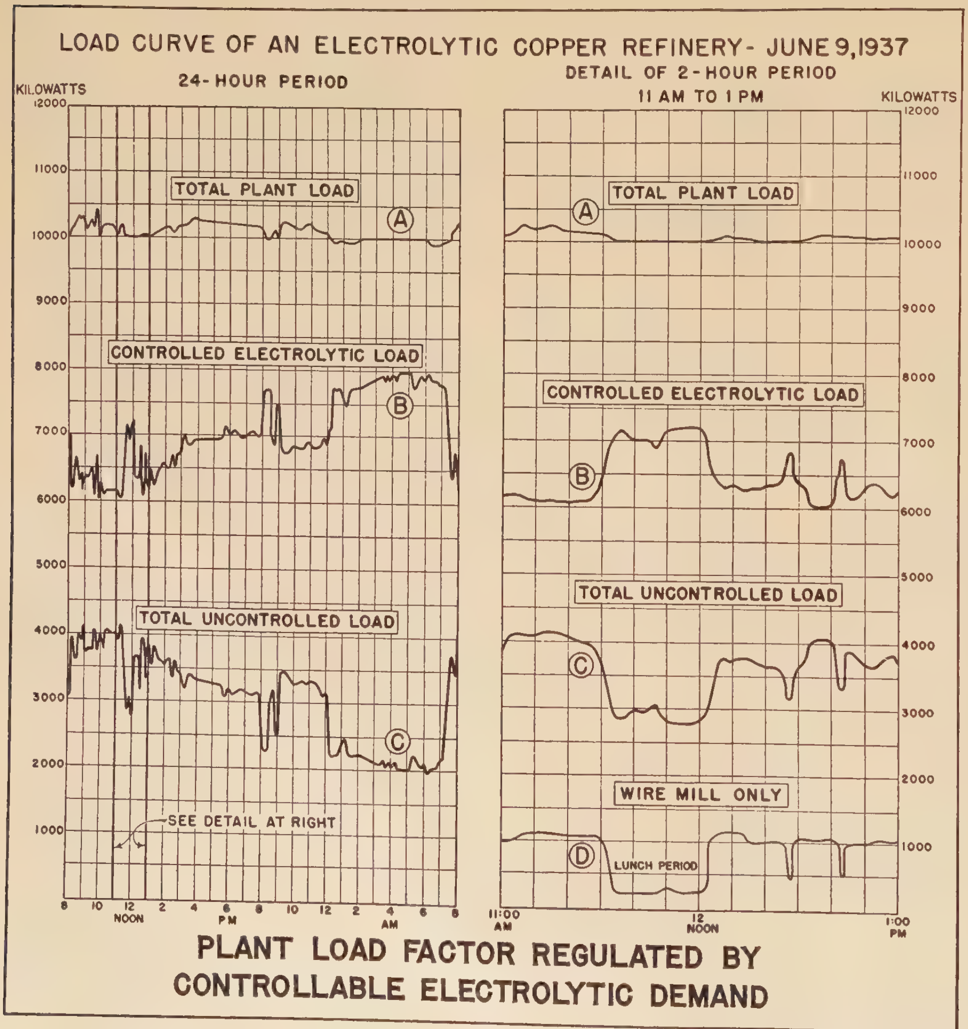
a. The installed capacity of generating equipment is given for all of the products and processes included in the Federal Power Commission report, except chlorine and caustic soda, electric steel and iron, and inorganic fertilizers.

b. Included in the capacity of generating equipment.

ting tools that would retain their hardness even at red heat has brought about the development of a growing list of metal carbides which are produced in electric furnaces, powdered, and then sintered in another type of electric furnace with a binder such as cobalt. Some of these materials approach the diamond in hardness.

The United States Bureau of Mines, as well as other public and private agencies, is developing new processes utilizing electric energy and domestic raw materials. One of these obtains manganese by electrolysis from domestic low-grade ores; another obtains alumina, silica, and potash from domestic alunite ore by an electric-furnace method. Carbon bisulphide, silicon, fused silica, fused quartz, phosphoric acid, and phosphorus are among the electric-furnace materials whose combined production has as yet required relatively small quantities of electric power. Phosphates have assumed considerable significance within the last three years. Decreasing power rates may have an important bearing on the quantities of these and other materials produced electrically, and therefore on the consumption of electric energy.

These are but examples of the many new processes and new products already in laboratory or pilot plant or early commercial stages of development. Many others have appeared or are on the technical horizon. Not every one of these can be expected to succeed commercially as have aluminum, stainless steel, and electrolytic copper. But it would be surprising if there are not several that will rival the present importance of these materials in



—*Federal Power Commission.*

Figure 5

At this refinery the demand of the electrolytic department—which would otherwise be almost uniform—is controlled automatically to compensate for the variable loads of other plant operations and obtain a combined load factor approaching 100 per cent

This chart, taken from graphic meter readings, shows that the variations in the electrolytic demand (*B*) throughout the day were so controlled as to be equal and opposite to those in other plant operations (*C*), while the combined plant load (*A*) remained almost constant. Thus at about 11:30 a.m. the electrolytic demand was automatically increased by 1,050 kw to compensate for the sharp drop in the other loads that occurred when the wire mill (*D*), shut down for lunch

The automatic control equipment is actuated through relays by the variable combined demand; it changes the field excitation in the motor generators that supply the d-c energy for electrolysis, which in turn changes the d-c voltage and therefore the power drawn by the cells

Table V. Cost of Power Related to Price of Product (Power Costs of 5 to 15 Per Cent of Selling Price Are Shown in *italics*)

Product (1)	Unit of Measure (2)	Unit Selling Price (Dollars)[a] (3)	Unit Electric Energy Requirements (Kilowatt-Hours)[b] (4)	Ratio (Per Cent) of Electric Energy Cost to Selling Price of Finished Product at Selected Average Unit Costs of Energy (Cents per Kilowatt-Hour): 0.1 (5)	0.2 (6)	0.25 (7)	0.3 (8)	0.35 (9)	0.4 (10)	0.5 (11)	0.6 (12)	0.7 (13)	0.8 (14)	0.9 (15)	1.0 (16)	Energy Costs of Representative Producers (Cents per Kilowatt-Hour) (17)
Electrolytic:																
Aluminum	Short ton	400.00	23,988	*6.0*	*12.0*	*15.0*	18.0	21.0	24.0	30.0	36.0	42.0	48.0	54.0	60.0	c
Copper (electrolytic leaching)	Short ton	220.00	2,820[d]	1.3	2.6	3.2	3.8	4.5	*5.1*	*6.4*	*7.7*	*9.0*	*10.3*	*11.5*	*12.8*	0.65
Copper (electrolytic) refining)	Short ton	220.00	367	0.2	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.3	1.5	1.7	0.70
Zinc	Short ton	100.00	3,714	3.7	*7.4*	*9.3*	*11.1*	*13.0*	*14.9*	18.6	22.3	26.0	29.7	33.4	37.1	0 25,0.5
Magnesium	Short ton	600.00	20,000	3.3	*6.7*	*8.3*	*10.0*	*11.7*	*13.3*	16.7	20.0	23.3	26.7	30.0	33.3	c
Sodium (metallic)	Short ton of metallic sodium and 3,083 lb of chlorine	376.28[e]	14,400[d]	3.8	*7.7*	*9.6*	*11.5*	*13.4*	15.3	19.1	23.0	26.8	30.6	34.4	38.3	0.35
Chlorine and caustic soda	Short ton of caustic soda and 1,770 lb of chlorine	109.16[f]	3,009	2.8	*5.5*	*6.9*	*8.3*	*9.6*	*11.0*	*13.8*	16.5	19.3	22.1	24.8	27.6	0.35
Electrothermal:																
Ferromanganese 80 per cent	Long ton	102.50	7,280[d]	*7.1*	*14.2*	17.8	21.3	24.9	28.4	35.5	42.6	49.7	56.8	63.9	71.0	c
Ferrosilicon 50 per cent	Long ton	69.50	6,160[d]	*8.9*	17.7	22.2	26.6	31.0	35.5	44.3	53.2	62.0	70.9	80.0	88.6	0.3, 0.5
Fused alumina	Short ton	56.04[g]	3,143	*5.6*	*11.2*	*14.0*	16.8	19.6	22.4	28.0	33.7	39.3	44.9	50.5	56.1	0.35
Silicon carbide	Short ton	72 93[g]	9,380	*12.9*	25.7	32.2	38.6	45.0	51.4	64.3	77.2	90.0	102.9	115.8	128.6	0.35
Calcium carbide	Short ton	100.00	3,150	3.2	*6.3*	*7.9*	9.4	*11.0*	*12.6*	15.8	18.9	22.0	25.2	28.4	31.5	0.35
Allied:																
Anhydrous ammonia	Short ton	90.00	1,530	1.7	3.4	4.2	*5.1*	*6.0*	*6.8*	*8.5*	*10.2*	*11.9*	*13.6*	15.3	17.0	0.3–0.5

a. Represents manufacturers' prices as of January 3, 1938, from prices published by *Oil Paint and Drug Reporter*, *Engineering and Mining Journal*, and *Industrial and Engineering Chemistry*, except as noted.

b. Represents all energy directly chargeable to each product for the operation specified, including electrolytic, electrothermal, motor, lighting, and incidental loads.

c. Representative data are not available.

d. Represents energy directly chargeable to process only.

e. Based on a price of 15.5 cents per pound for metallic sodium and 2.15 cents per pound for chlorine.

f. Based on a price of 2.7 cents per pound for caustic soda (76 per cent solid) and 2.15 cents per pound for chlorine.

g. Average value of United States and Canadian production of crude material during 1936, from data published by the United States Bureau of Mines

their requirements for electric energy and their contribution to the resources of modern civilization.

Probable Resultant Trends

Past experience and the present outlook indicate that the total electric requirements of this particular group of industries will expand at a rate somewhat greater than that of general industrial activity, because requirements for the products themselves are clearly increasing at rates higher than the average.

Added to this underlying tendency will be the potentially much larger incremental use of electric energy where changing conditions make the electroprocesses more advantageous or less costly than older methods, as well as perhaps equally great increments obtained from new products and processes now in various stages of development. Such compounding of growth factors should be recognized in providing for the national power requirements of the near future, particularly in regions where the availability of raw materials and low-cost electric power are favorable to these developments.

On the north Pacific coast large and immediate possibilities of low-cost hydroelectric energy suggest the definite possibility of aluminum reduction from foreign ores to be delivered by cargo shipment on the Columbia River or on Puget Sound. The availability of iron ore, of iron and steel scrap, and of coking coal suitable for electric furnace production, and the relatively small local capacity now installed, indicate that the electric production of iron and steel alloys may be commercially feasible in the near future.

Widespread deposits of manganese, chromium, and other ores strengthen the possibility of ferroalloy production. Extensive resources of phosphate rock in Idaho, Wyoming, Utah, and Montana are available for the manufacture of phosphoric acid and phosphates.[3] More immediate prospects for the development of sodium chlorate and of calcium carbide are also to be noted.

In the southwestern states, ferroalloys and especially ferromanganese offer distinct possibilities. Zinc deposits near Pioche, Nev., are favorable for either electrolytic or electrothermal production of zinc and zinc oxides. Magnesites in California and alunites in Utah may be used for production of electrolytic magnesium and electric-furnace potash.[3] The ability to make potassium nitrate from potassium chloride and nitrogen peroxide (derived from ammonia), together with the potential need for additional ammonia for fertilizer use, indicate that new capacity for synthetic ammonia may be expected; perhaps utilizing power from Boulder Dam.

In the southeast, the greatly increased production of paper and pulp from enormous regional resources of timber foreshadows a future need for power in these operations and also in the production of chlorine and caustic soda for process purposes. Electric furnace

Table VI. Consumption of Electric Energy per Year

Product	Past Requirements[a] (Kilowatt-Hours)	Future Requirements Probable Within Five Years (Kilowatt-Hours)	Ratio to Past Requirements (Per Cent)
Aluminum	2,597,000,000	3,600,000,000	139
Copper	2,600,000,000	2,500,000,000	96
Zinc (electrolytic)	515,000,000	850,000,000	165
Magnesium	39,000,000	100,000,000	256
Chlorine and caustic soda (electrolytic)	1,568,000,000	1,900,000,000	121
Electric furnace iron	105,000,000	200,000,000	190
Electric furnace steel	743,000,000	1,100,000,000	148
Electric furnace ferroalloys	1,752,000,000	2,500,000,000	143
Heat treating	2,200,000,000	3,000,000,000	136
Artificial abrasives	87,000,000	116,000,000	133
Calcium carbide	550,000,000	1,100,000,000	200
Carbon and graphitized products	196,000,000	300,000,000	153
Nitrogen	288,000,000	375,000,000	130
Potash	84,000,000	140,000,000	167
Total	13,324,000,000[a]	17,781,000,000	133

a. Year 1936; except for copper, where 1929 is used because it is the only year for which complete data on power consumed in mining, milling, smelting, and refining of copper are available. For this reason and also because energy requirements for cadmium, brass, and inorganic fertilizers are not included, the total shown cannot be reconciled with the figure of 12,500,000,000 kilowatt-hours given for 1936.

production of phosphoric acid and phosphates has begun near Sheffield, Ala., Anniston, Ala., and Nichols, Fla.

Increased production of ferroalloys and of calcium carbide is presaged by the announced construction of new capacity[3] and by the availability of raw materials, local markets, and low-cost power. The many deposits of dolomite in the Tennessee Valley suggest the possibility of developing a local magnesium industry when domestic demands exceed the existing capacity at Midland, Mich.[3]

Estimates of future power requirements affecting the electroprocessing industries are based on past growth, on probable changes in the markets for the materials in their older uses, on new uses and new processes that are known to be of prospective importance, and on the continued availability of low-cost electric energy in certain regions.[3]

Extraordinary influences, such as a war or a major change in the business cycle, have been excluded from consideration as being impossible to evaluate usefully either in magnitude or in time of occurrence. The high level recorded in the first nine months of 1937 has been discounted, together with the sharp curtailment of power consumption which began in the last quarter of the same year.

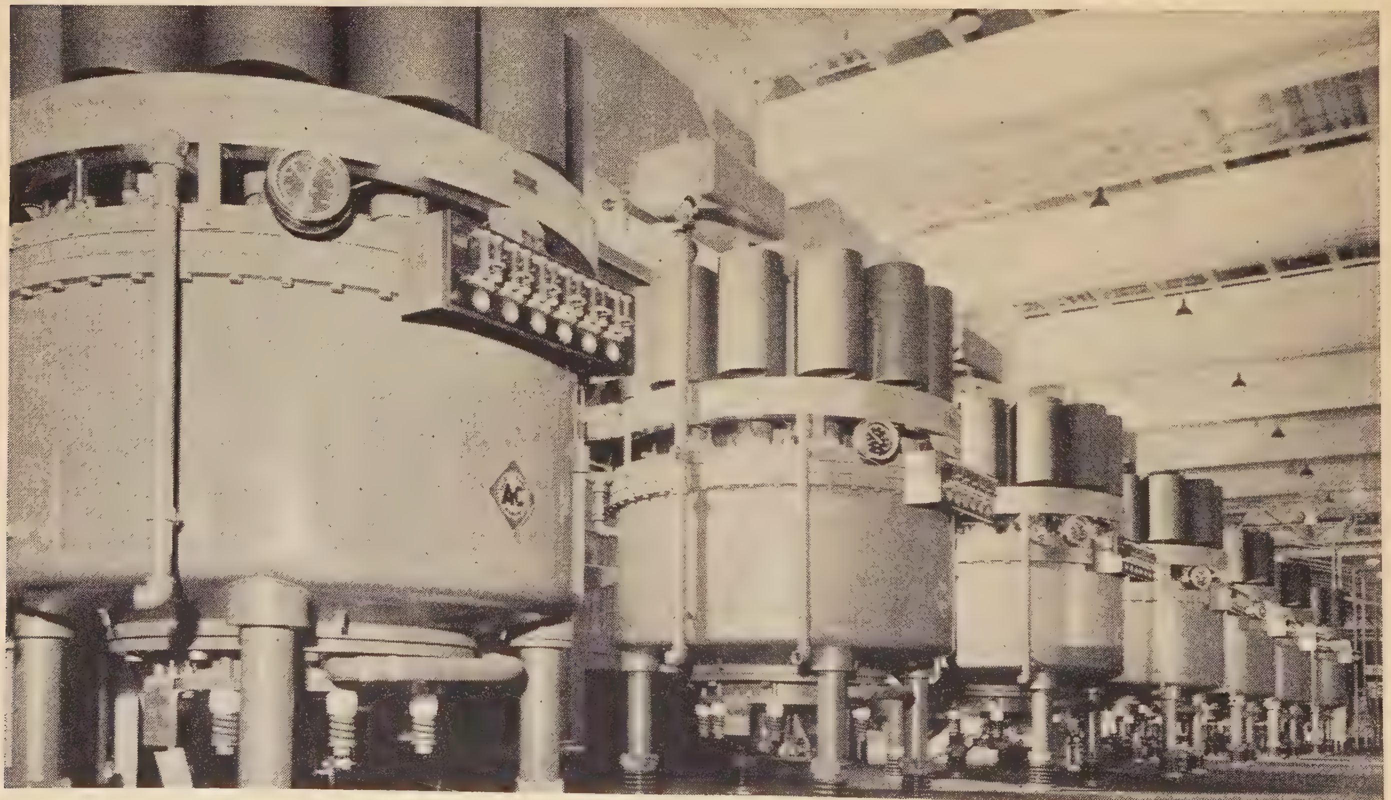
The problem of estimating these future power requirements is not to establish whether they will occur, but rather to indicate their approach sufficiently far in advance to permit the orderly development of power resources to meet the increased needs. A summary of these estimates, compared with the recorded actual consumption, is presented in table VI.

References

1. Monthly and Annual Production of Electricity for Public Use, Federal Power Commission, April 12, 1937, page 1.

2. Economies Resulting From Improved Regulation, **J. V. Alfriend, Jr.,** *Chemical and Metallurgical Engineering*, April 1932, pages 209–11.

3. Power Requirements in Electrochemical, Electrometallurgical, and Allied Industries, Federal Power Commission, 1938.



These mercury-arc rectifiers at the Alcoa, Tenn., plant of the Aluminum Company of America have 55,000-kw capacity

News

Of Institute and Related Activities

Treasure Island Awaits Summer Conventioneers

THE combined AIEE summer and Pacific Coast convention, which will be held in San Francisco, Calif., June 26–30, 1939, offers members and guests unusual opportunities to combine business and pleasure. The technical program will include outstanding papers on a variety of pertinent subjects, round-table conferences, student meetings, and related activities. Entertainment will feature the Golden Gate International Exposition, which has designated Tuesday, June 27, as AIEE Day. Sports and entertainment have been arranged and extensive plans have been made to entertain the women guests.

The Golden Gate International Exposition, located on man-made Treasure Island in the middle of San Francisco Bay, is easily accessible by auto, taxi, or ferry; compactly designed, all of its many features are within easy walking distance of each other. Old masters, including priceless works loaned by the Italian Government, and modern painting feature an exceptional exhibit of art. Fluorescent-tube lighting is employed extensively. Exterior floodlighting of buildings, trees, shrubs, and flowers is particularly good. The total electrical load is equal to the demands of a city of 50,000.

Immediate Hotel Reservations Necessary

Convention headquarters will be at the Fairmont Hotel, which overlooks San Francisco Bay and Treasure Island. Since hotel accommodations in the city are expected to be in great demand because of the exposition, members are urged to make early reservations. It is extremely important that reservations, if not already made, be made immediately. The rates for the Fairmont, as well as for several other principal hotels in San Francisco, were given in a preliminary announcement of the convention in the April issue, page 177.

San Francisco and its environs provide many scenic attractions for those traveling to and from the convention. The bay area, California, and the entire Pacific Coast abound with natural attractions of wide variety. Near San Francisco are Muir Woods, Mount Tamalpais, and the ocean beaches. Within an easy one-day drive are Varmel, Monterey, Del Monte, Santa Cruz, and Big Basin. Slightly farther away are the Redwood Empire, Yosemite National Park, Lassen Park, General Grant and Sequoia Parks, and Lake Tahoe. In Southern California the many beaches, the movie studios, and other attractions lure many tourists. Oregon, Washington, and British Columbia likewise contain many points of interest. Visitors from east of the Rockies may well include Grand Canyon, Boulder Dam, Grand Coulee, Glacier Park, or Yellowstone Park in their itineraries. Those who prefer to motor will find the highways to California numerous and in good condition. For those traveling from New England and the Atlantic Seaboard region special accommodations with connections at Chicago, Ill., and St. Louis, Mo., offered by the New York Central System were described in the April issue, page 177.

Technical Sessions

The program will comprise nine or ten technical sessions, four or five round-table discussions, and student technical sessions. With a view toward including as many papers as possible on some of the latest technical developments details of the technical program could not be included in this announcement, but will be given in the June issue. Subjects that will form the basis for sessions arranged so far are as follows: protective devices, communication, instruments and measurements, electrical machinery, power transmission and distribution, industrial power applications, electronics, basic sciences, research, automatic stations, lighting, and transportation.

Entertainment

For the purpose of getting acquainted, an informal reception and tea for members and their guests will be held Monday afternoon, June 26, at five o'clock at the Hotel Mark Hopkins, directly across the street from the Fairmont Hotel. Tickets are free but must be secured at the registration desk by two o'clock Monday to permit the hotel to make proper arrangements.

As previously stated, Tuesday is AIEE Day on Treasure Island. To allow everyone an opportunity to visit the exposition that day, no technical papers or conferences are scheduled for Tuesday afternoon. In the evening, there will be an informal dinner in the ballroom of the California State Building. Tickets will be two dollars per plate and must be obtained at the registration desk, Fairmont Hotel, not later than eight o'clock Monday evening.

The convention banquet with entertain-

Tentative Schedule of Events

All Sessions and Conferences Will Be Held at the Fairmont Hotel

Monday, June 26

8:30 a.m.—Registration (desk open Sunday—2:00 to 8:30 p.m.)

10:00 a.m.—Annual Meeting
Reports, presentation of prizes for papers, presentation of Lamme Medal, and president's address

Afternoon —Sports

2:00 p.m.—Conference of officers, delegates, and members
San Francisco bus trip for ladies

5:00 p.m.—Informal reception and tea for men and women, Mark Hopkins Hotel

Tuesday, June 27

9:00 a.m.—Three parallel technical sessions

Afternoon —Sports
AIEE Day at Golden Gate International Exposition, Treasure Island

6:00 p.m.—Treasure Island—dinner (informal) in ballroom, California State Building

Wednesday, June 28

9:00 a.m.—General session

Afternoon —Sports

2:00 p.m.—Conference of officers, delegates, and members
Two or three round-table discussions
Student technical sessions

7:00 p.m.—Student Branch dinner, followed by joint conference of Student delegates and counselors of Districts 8 and 9

Thursday, June 29

9:00 a.m.—Three parallel technical sessions

11:30 a.m.—Peninsula bus trip and tea for women (return by 5:30 p.m.)

Afternoon —Sports

2:00 p.m.—Student technical sessions
Two or three round-table discussions
Bridge at hotel (alternative)

7:00 p.m.—Convention banquet (awarding of sports' prizes)—Hotel Fairmont

9:00 p.m.—Dancing

Friday, June 30

9:00 a.m.—Three parallel technical sessions

Afternoon —Inspection trips

ment and dancing will be held at the Fairmont Hotel, Thursday evening, at seven. The sports' prizes will be presented, and all members and guests are urged to attend this closing entertainment feature of the convention.

Women's Entertainment

On Monday at two o'clock busses will leave the Fairmont Hotel on a trip to outstanding points of interest around San Francisco. This trip will follow to a large extent the celebrated "45-mile scenic drive" and will take about two hours. Men are invited. Tickets will be free for out-of-town members and guests, and one dollar each for residents of the bay area. All tickets must be obtained in advance at the registration desk.

A trip for women through San Mateo County has been arranged for Thursday; the party will leave the Fairmont Hotel at 11:30 a.m. Luncheon will be served in Palo Alto at the Allied Arts, which is noted for its handicraft arts, its fine cuisine, and beautiful surroundings. After lunch, the Stanford University grounds will be visited, and the return to San Francisco will be through the many attractive suburban communities which dot the peninsula. Tickets must be obtained at the Fairmont Hotel by eight o'clock Wednesday evening.

Sports

Excellent facilities for golf and tennis abound in San Francisco and the bay area. Swimming also may be enjoyed in the Fairmont pool. Golden Gate Park contains many miles of bridle trails.

The qualifying round, 18 holes, for the Mershon golf trophy and the first 18 holes of medal play for the Lee trophy will be played at the Claremont Country Club in Oakland, Monday afternoon. The last 18 holes for the Lee trophy, and the John B. Fisken cup competition, which is open only to members of AIEE Districts 8 and 9, will be played on this course Thursday afternoon. Play at other times and on other courses may be arranged by request to members of the sports committee.

The Mershon tennis tournament for men, and other matches for both men and women, will be played at the California Tennis Club in San Francisco. Play will commence Monday afternoon.

Inspection Trips

Stanford University. A half-day trip to this institution will include a special demonstration at the Ryan High-Voltage Laboratory.

University of California. A trip across the San Francisco Bay Bridge to the university campus will include a visit to the recently completed cyclotron.

Station "A," San Francisco. Largest steam plant of the Pacific Gas and Electric Company, with two 50,000-kw turbines operating at a steam pressure of 1,400 pounds per square inch.

Sterling Substation. Located at the San Francisco terminus of the Bay Bridge, this station contains 600-volt and 1,300-volt rectifiers supplying the two interurban railway systems using third rail and trolley. The train control and signal system across the bridge, one of the busiest of double-track interurban railways, also may be inspected.

Newark Substation. This station is the terminus of 2 220-kv, 16 110-kv, and 3 60-kv lines, with 227,500-kva transformer and 75,000-kva synchronous condenser capacity.

Registration

Members who will attend the convention should register in advance by filling in and mailing the advance registration card received with the mailed announcement. This will assist the committees in making advance arrangements and minimizing congestion at the registration desk upon arrival. A registration fee of three dollars will be charged all nonmembers except Enrolled Students and the immediate families of members.

Convention Committee

The personnel of the 1939 summer and Pacific Coast Convention committee is as follows: S. J. Lisberger, *general chairman;* D. I. Cone, *vice-chairman;* G. C. Tenney, *secretary;* R. O. Brosemer, *treasurer;* F. S. Benson, A. M. Bohnert, C. F. Bowman, C. B. Carpenter, O. B. Coldwell, P. M. Downing, C. E. Fleager, L. F. Fuller, L. R. Gamble, David Hall, N. B. Hinson, J. P. Jollyman, R. E. Kistler, H. J. MacLeod, J. A. McDonald, P. J. Ost, G. E., Quinan, C. E. Rogers, E. F. Scattergood, R. W. Sorensen, H. A. Stingle, and F. E. Terman. Subcommittee chairmen: M. S. Barnes, *registration;* R. J. Cobban, *sports;* E. A. Crellin, *hotel;* H. W. Flye, *entertainment and reception;* F. R. George, *trips and local transportation;* J. S. Moulton, *publicity;* Stanley Rapp, *transportation;* H. H. Skilling, *student activities;* W. C. Smith, *program;* and Mrs. S. J. Lisberger, *women's entertainment.*

Notice of Annual Meeting

The annual meeting of the American Institute of Electrical Engineers will be held at the Fairmont Hotel, San Francisco, Calif., at 10 a.m. on Monday, June 26, 1939. This will constitute one session of the summer and Pacific Coast convention which is to be held this year in that city.

At this meeting, the annual report of the board of directors, and the report of the committee of tellers on the ballots cast for the election of officers will be presented.

Such other business, if any, as properly may come before the annual meeting may be considered.

(Signed) H. H. Henline
National Secretary

New Book on Power Transmission. "Electrical Transmission and Distribution of Power" has recently been published by Dean H. V. Carpenter (A'03, F'18) of the State College of Washington, Pullman. Written to serve a triple purpose—senior text, guide to related periodical and other technical literature, useful reference book for an engineering office—this book has been published by the lithoprint process, contains 100 8½- by 11-inch pages, and is multi-ring bound to enable it to open flat as a convenience of use. It has been announced as available at $2.00 per copy postpaid from the Student Book Store, Pullman, Wash.

Summer Convention Attenders May See

(1) The 1939 Golden Gate International Exposition. On Treasure Island, man-made site of the exposition in San Francisco Bay, the towers, courts, and palaces of the grounds are here seen from nearby Yerba Buena Island

(2) Exposition exhibits of particular interest to AIEE members. The fluted building of the Westinghouse Electric and Manufacturing Company, in the Palace of Electricity and Communications, contains X-ray apparatus, single-stage geared turbine demonstrator, electrical porcelain, household appliances, "Elektro" the automaton, and other displays

(3) The magnificent scenery of the western United States. Here shown is El Capitan cliff, rising sheer for 3,600 feet in Yosemite National Park, Calif. Besides scenic features of California, conventioners may make the trip include the Grand Canyon, Yellowstone Park, or the Canadian Rockies (Southern Pacific photo)

(4) Interesting industrial plants. Illustrated is the oil-circuit-breaker assembly floor at the Pacific Electric Manufacturing Company, San Francisco, Calif.

(5) More Golden Gate Exposition exhibits. The General Electric Company features half-hour stage shows in its House of Magic; also offers for inspection an international broadcasting station, a "magic kitchen," which moves and talks, and a glass blower making replicas of Edison's first incandescent lamp

(6) The unique "Pacific" architecture of the exposition. Pylons adjoining the palaces on the Court of the Seven Seas are crowned with galleon prows ornamented with sculptured figureheads

(7) The only Chinese telephone office outside China. The Chinatown exchange of the Pacific Telephone and Telegraph Company, San Francisco, Calif., occupies a building of Chinese design, with triple pagodas to indicate its importance

(8) Power equipment. Shown here is Station "C," of the Pacific Gas and Electric Company, Oakland, Calif. The plant was recently enlarged to a total generating capacity of 155,999 horsepower; the first unit, built in 1908, had a capacity of only 12,000 horsepower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Progress Reported in Conference on Sound Measurement

THE conference on sound measurement held during the AIEE 1939 winter convention, under sponsorship of the subcommittee on sound of the AIEE standards committee, attracted widespread interest; the discussion was participated in by some 20 speakers, and the total attendance was well over 100. This summary report of the conference was prepared by P. L. Alger, chairman of the subcommittee.

Marked progress in the accuracy and uniformity of sound measurement was reported, numerous recent comparisons of sound-level meters of different makes at the Bureau of Standards and elsewhere having shown agreement to the order of one decibel, as contrasted with a seven-decibel range of discrepancy noted a year ago.

R. G. McCurdy (A'16, F'34) reported on conferences held with experts abroad, on his recent trip to Europe. French, German, and English authorities are now generally agreed on the use of objective noise meters, similar to the American standard type, for all usual noise measurements, but there is still a considerable difference of opinion on the most desirable dynamic characteristics of the meter, and on the exact relations between the true loudness of a complex noise and the meter reading itself. The International Committee on Acoustics delayed action on the adoption of sound-level-meter standards for international use because of this difference of opinion. The International Committee on Telephony (CCIF) however, has tentatively adopted the American sound-level-meter standard for the measurement of room noises.

Standard American meters have a time of response of 0.2 to 0.25 second, which results in some averaging effect on rapidly varying noises. There is a considerable volume of opinion, which desires a shorter time of response, or some form of peak-noise-reading meter, to read more nearly the maximum than the average sound level of such noises as produced by a riveting hammer or by the exhaust of a gasoline engine. Mr. McCurdy stated, however, that none of the information or opinions noted abroad warranted, in his opinion, any present change in the American sound-level-meter standards.

General opinion both here and abroad is that the true loudness of a complex noise, as judged by a large number of observers, increases somewhat more rapidly with the sound energy level than is indicated by the standard objective type of sound-level meter. The term "phon" has been adopted internationally as the name for this psychological sound level, as judged by the average observer, and several investigators have proposed approximate calibration curves to correct the decibel reading of a sound-level meter to the equivalent "phon" value. The values obtained by different observers vary considerably, however, and the magnitudes of the corrections to the objective meter readings have not been well enough established to warrant their use at present.

V. L. Chrisler reported on the work of the Bureau of Standards in developing basic reference standards and calibration methods. He said that comparisons of several commercially available types of meters and microphones, including the new ribbon microphone design, have shown agreement within one-half decibel, except for the obstacle effect present when large microphones are used. The Bureau is now willing to calibrate microphones and sound-level meters as a routine test for an appropriate fee. He also reported that various governmental authorities are now requiring noise guarantees to be met in the purchase of fans and other apparatus, so that the Bureau is especially interested in the development of more precise commercial test codes for noise measurement.

J. M. Barstow described work done by the Bell Telephone Laboratories with an "acoustical calibrator," or standard reference noise, which was exhibited at the meeting of the Acoustical Society of America in Washington, D. C., last summer. Discussion indicated that there is an important need for a standard reference source of a complex noise of this type for use in field calibration of meters, and it was agreed that the committee should give further study to this subject.

G. T. Stanton suggested that a second type of objective sound-level meter should be developed, especially for use in commercial measurements of apparatus noise, where one or two definite frequencies compose a major part of the sound energy. He pointed out that the tolerance of five decibels or more in the frequency response permitted by present American standards is so large that comparisons of measurements made at different places and with different meters are not sufficiently accurate for some purposes. Paul Huber supported this proposal, and stated that a large automotive organization maintains ten sound-level meters in field service continuously, comparing noise levels produced by automobile engines and similar equipment in different locations and with different lengths of service. Discussion indicated, however, that the tolerance permitted by the standards is required to cover variations in the response of individual microphones to particular frequencies, and that the actual tolerance between complex noise readings, which cover a range of frequencies, is much closer than the standards would indicate. Furthermore, if a meter is calibrated with a particular microphone, corrections can be made which will enable an accuracy of one or two decibels in comparisons to be obtained. It was concluded, therefore, that the present need is to develop more convenient and accurate calibration methods, rather than to modify the standards. The committee, however, decided to review the American standards in this respect and suggest any reductions in tolerances or other alterations that seem desirable.

D. F. Seacord (A'18) presented a report on the sound levels existing in offices, factories, and residences, compiled from measurements in 900 different locations. Besides giving average sound levels in these different locations, he showed the range of variation existing, the numerical values being approximately as follows:

For the typical residence, the sound-level averages approximately 40 decibels, 95 per cent of the observed values lying within a range of 30 to 50 decibels.

For large business offices, the average level is about 57 decibels, 95 per cent of the values lying between about 38 and 75 decibels.

For factories, the average level is about 77 decibels, with a range from 60 to 95 decibels.

All these readings were taken at locations adjacent to a telephone, the purpose in view being to obtain information to be used as a basis for working out methods for more accurately reflecting the effects of room noise in the design of the telephone plant.

W. Mikelson presented a report on the AIEE Test Code for Apparatus Noise Measurement, which was published in preliminary form in the September 1937 issue of ELECTRICAL ENGINEERING. Since that time a number of suggestions have been received concerning it, and experience also has indicated the desirability of minor changes. On this basis, several changes in the code were agreed upon, and subsequently the subcommittee voted to transmit the amended code to the standards committee with recommendation for printing by the Institute.

The 3 principal changes were the permissive use of maximum instead of average sound-level readings, in the case of some small apparatus types with highly directional noise characteristics; a more complete statement in regard to the method of averaging sound-level readings; and the inclusion of information in regard to the apparent loudness of a sound in comparison with its decibel value indicated by a meter.

Anthony Pinto (A'11, M'18) presented information on the work of several committees of the National Electrical Manufacturers Association that are drafting specific test codes for measurement of apparatus noise, particularly fans, small motors, and transformers. The NEMA Transformer Code has recently been approved, and the fan and motor codes are now in draft form, so that requests for quiet apparatus can be handled on a satisfactory commercial basis. In general, these specific test codes require the averaging of sound-level measurements taken at points 45 degrees apart along a line encircling the apparatus at a distance of one foot for motors and transformers, and three feet for fans. These NEMA codes are so drawn as to be in accord with the basic values in the AIEE Test Code. Discussion at the meeting stressed the desirability of having all apparatus test codes to be developed by the different commercial organizations similarly agree with the basic AIEE Test Code, to avoid confusion and permit the most accurate comparisons. The value of these conferences, in developing the co-operation necessary to secure this basic uniformity between test codes was strongly pointed out by several speakers.

The final speaker at the conference was A. P. Fugill (A'24, M'30) who presented a report on the experience of The Detroit Edison Company in purchasing transformers under a noise specification. This specification was presented in preliminary form at the 1938 conference. Mr. Fugill stated that a number of careful comparisons of the sound level of particular transformers,

measured first at the factory both by the manufacturer and by The Detroit Edison Company representative using his own meter, and then by The Detroit Edison Company at the company's warehouse, have shown a difference in every case of less than two decibels, with an average error of materially less than one decibel. As a result of extensive observations on transformers under warehouse and field conditions, a curve of satisfactory sound levels versus transformer capacity has been established, and all transformers purchased by the company are now required to come within these values.

AIEE 17-Year Index Now Completed

The fourth in the series of published indexes to technical papers and discussions published in the AIEE TRANSACTIONS is now off the press and ready for distribution. Covering the years 1922–38, inclusive, the volume contains 160 pages and its over-all dimensions and type of binding are similar to those of recent TRANSACTIONS volumes.

In preparing the index, maximum serviceability to its users is the factor that has been given the greatest consideration. The titles of all technical papers published during the 17-year period are liberally cross-referenced in section 1, which comprises the subject index. In section 2, the author index, are listed the names of all authors and co-authors of all papers and discussions published during that period.

TWO INDEXES FOR THE PRICE OF ONE

The new index volume is nominally priced at $2.00 per copy, postpaid; $3.00 to nonmembers, with the usual discounts to college and public libraries. As an added inducement, a copy of the last preceding index volume, covering papers and discussions published during the years 1911–21, will be included free of charge with every copy of the new index.

Those who already have ordered copies of the new index, in response to previous announcements, will receive their copies within a short time. Those who have not already ordered and wish to do so now may find a convenient order form on page 1, advertising section, this issue. Since the edition is limited, it is important that orders be placed promptly.

NEMA Conference With Department of Commerce

A series of meetings presenting services of the United States Department of Commerce available to all electrical manufacturers was held March 30 and 31, 1939, at the Department of Commerce Building, Washington, D. C., under the auspices of the National Electrical Manufacturers' Association.

Harry L. Hopkins, Secretary of Commerce, greeted the delegates at the opening session. Speakers from various bureaus of the Department discussed the services available and their special application to electrical manufacturing in four conference sessions.

The first session dealt with domestic commerce services of the Bureau of Foreign and Domestic Commerce; the second with services of the Census Bureau; the third included activities of the Patent Office, National Bureau of Standards, and the Trade Agreements Unit of the Bureau of Foreign and Domestic Commerce; and the final session was concerned with foreign commerce services of the Bureau of Foreign and Domestic Commerce.

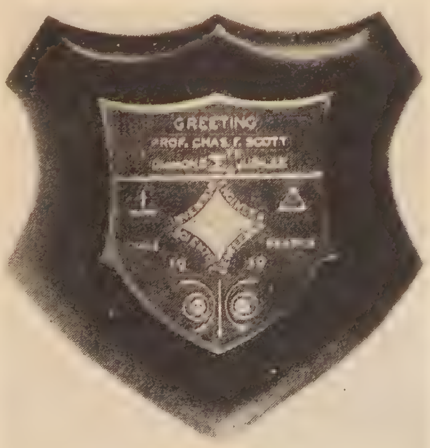
At the dinner meeting on March 30 the speakers were Dr. Willard L. Thorp, special economic advisor to the Secretary of Commerce, on "The National Economic Survey," and Richard C. Patterson, Jr., Assistant Secretary of Commerce, on "What are the Prospects for Business." Carl L. Peirce, Jr., president, NEMA, presided at the dinner.

AIEE Yale Branch Honors Doctor Scott

AIEE Student Branch recognition of the approaching 75th birthday of Doctor C. F. Scott (A'92, F'25, HM'29) began with a dinner and meeting given in Doctor Scott's honor by the Yale University Branch, New Haven, Conn., March 17, 1939. Doctor Scott, who inaugurated Student Branches during his presidency of the AIEE 1902–03, was head of the department of electrical engineering at Yale for 22 years, and himself founded the Yale Branch. Yale therefore arranged to be the first of the Student Branches to commemorate the "diamond jubilee" of their founder, acting upon the suggestion made last year by R. W. Sorensen, chairman, committee on Student Branches.

Photos by J. L. Daley

Doctor C. F. Scott receives from J. G. Stephenson, chairman, AIEE Yale Student Branch, the commemorative plaque shown here, expressing student appreciation of his attainments



The celebration at New Haven began with a banquet at the Yale Faculty Club, followed by a meeting of students and faculty members, at which Doctor Scott spoke on the development of electric power at Niagara Falls, the invention of the two-phase—three-phase Scott connection, and other matters of engineering history. He was introduced by Branch Chairman J. G. Stephenson, whose tribute was partly in verse form, and both introduction and address were interrupted at strategic intervals by humorous songs by a trio of students. At the conclusion of his speech, Doctor Scott was presented with a complimentary plaque as a symbol of student appreciation of his achievements. The meeting, which ended with an informal reception, was reported by J. G. Stephenson, Branch chairman, and A. E. Were, Branch secretary. The songs and other verses for the occasion were written by Professor A. G. Conrad (A'27) of the electrical-engineering department.

Future AIEE Meetings

North Eastern District Meeting
Springfield, Mass., May 3–5, 1939

Summer and Pacific Coast Convention (combined)
San Francisco, Calif., June 26–30, 1939

Great Lakes District Meeting
Minneapolis, Minn., September 27–29, 1939

Middle Eastern District Meeting
Scranton, Pa., October 11–13, 1939

Winter Convention
New York, N. Y., January 22–26, 1940

1939 AIEE Year Book Is Now Available

In accordance with the provisions of the Institute's 1938–39 budget as approved by the finance committee and the board of directors, the 1939 edition of the AIEE Year Book has been issued, in limited edition, and is available to members of the Institute who have use for it. The book contains essentially the same material as was included in the 1938 edition; business and mailing addresses have been corrected as of February 28, 1939.

In keeping with established custom, copies of the Year Book have been distributed to all national, District, and Section officers, to Student Branch counselors, and to all members of all national committees. Other members wishing to secure a copy may do so by writing to the AIEE order department, 33 West 39th Street,

New York, N. Y., giving correct mailing addresses.

The Year Book is not available to nonmembers of the Institute, nor is its use permitted for commercial, promotional, or other circularization purposes.

Engineers' Day at San Francisco Fair. Designated as Engineers' Day, Wednesday, July 13, 1939 at the Golden Gate International Exposition in San Francisco, Calif., will commemorate the engineer's contribution to human welfare. The celebration, which is sponsored by the San Francisco Engineering Council, will include inspection of the outstanding engineering and industrial exhibits at the exposition. National conventions of several engineering and scientific societies are being held in San Francisco near the date chosen to honor engineering achievement.

New Index to ASTM Standards. The American Society for Testing Materials has issued a new Index to ASTM Standards and Tentative Standards, covering the 870 standards existing as of January 1, 1939. The Index, a 140-page booklet, six by nine inches in size, may be obtained without charge from ASTM headquarters, 260 South Broad Street, Philadelphia, Pa.

AIEE Mansfield Division Becomes 67th Section

The Mansfield (Ohio) division of the AIEE Cleveland Section which was formed in December 1938 (*EE, Jan. '39, p. 39–40*) has become the Mansfield Section, by recent action of the Institute's executive committee and committee on Sections. The 67th Section of the Institute includes in its territory Marion, Morrow, and Knox counties, Ohio, formerly in the Columbus Section; Crawford County, formerly in the Toledo Section; Richland County, formerly in the Cleveland Section; and Ashland County, formerly in the Akron Section. Transfer of these areas was authorized by the various Sections.

Members and applicants in the new Section now number 71. The officers are: chairman, C. A. Faust (A'35), advertising department, Ohio Brass Company, Mansfield; vice-chairman, H. F. Herbig (A'23), research engineer, North Electric Manufacturing Company, Galion; chairman of attendance and publicity, W. A. Barnes (A'24), chief engineer, Dominion Electrical Manufacturing Company, Mansfield; and secretary-treasurer, F. H. Milliken (A'33), design engineer, Ideal Electric and Manufacturing Company, Mansfield.

Officers of the newly organized AIEE Mansfield Section: left to right, Messrs. Barnes, Herbig, Faust, Milliken

Standards

Co-ordinating Committees on Standardization Activities

With each technical committee of the Institute carrying on its standardization work more or less independently of the others, certain unnecessary differences in various practices, such as the use of reference values, have crept in, detracting from the desired simplicity of the entire standards structure and resulting in confusion and misunderstanding. The standards committee, realizing this situation, felt that it should take what steps it could to bring about greater co-ordination of these standardization activities. It is realized, of course, that some of the subjects requiring co-ordination are under consideration by agencies outside of the Institute, and therefore every effort will be made to have the Institute committees co-operate with these agencies.

A survey of the standards activities has further brought out that there is standards work relating to broader subjects than those ordinarily falling within the scope of the existing technical committees which the Institute might carry on, or at least initiate to good advantage.

The standards committee has therefore decided to set up a number of co-ordinating committees for the following purposes:

(*a*). To compile data on existing conditions and standards which will assist in the co-ordination of standards avoiding duplications and inconsistencies.

(*b*). To prepare guiding principles to be used by other AIEE committees in their standards work.

(*c*). To maintain contact with all interested AIEE committees and assist in the co-ordination of AIEE standards with other national and international standards activities.

(*d*). To recommend, initiate, or sponsor through the standards committee setups in the ASA, IEC, and other standardization bodies which seem desirable or expedient for bringing about maximum co-ordination of standards in the electrical field.

(*e*). To initiate, in co-operation with interested AIEE technical committees, regular or informal Institute sessions for the purpose of discussing standardization matters.

In the activities of these co-ordinating committees or their subcommittees, care will be taken that the interested technical committees are represented either by their chairmen or by members designated by them.

The following four co-ordinating committees have already been organized, with chairmen as indicated:

1. Reference values for standards, J. F. Meyer, chairman.
2. Standard voltages and currents, C. A. Powel, chairman.
3. Insulation testing and co-ordination, C. A. Powel.
4. Basic principles for rating of electrical machines and apparatus, P. L. Alger, chairman.

The chairmen of these committees will report in detail on their plans and contemplated activities in future issues of ELECTRICAL ENGINEERING.

The standards committee feels that the membership in general should be informed regularly of any important standards activities of the Institute, and therefore a subcommittee on publicity, with P. L. Alger as chairman, has been appointed to report regularly in ELECTRICAL ENGINEERING any items of interest.

Co-ordinating Committee on Basic Principles for Rating

The standards committee has appointed AIEE co-ordinating committee 4 on basic principles for rating of electrical machinery and apparatus, to consider the information presented at the symposium on rating, held during the 1939 winter convention, and to review AIEE Standards No. 1, "General Principles Upon Which Temperature Limits Are Based in the Rating of Electrical Machinery and Apparatus." The following brief statement of objectives of this committee has been prepared by P. L. Alger, chairman, for the information of Institute members and others interested. Specific recommendations or information that may be helpful to the committee should be sent directly to the secretary, E. B. Paxton.

The committee as organized consists of a small working committee and a large advisory committee, including representatives from all of the AIEE technical committees and other Institute members especially interested in rating problems. In order to keep the Institute membership informed of progress in this work and to obtain additional information bearing on the subject, it is proposed to have one or more papers and discussion sponsored by the committee at both the combined summer and Pacific Coast convention, San Francisco, Calif., June 26–30, 1939, and the Middle Eastern District meeting, Scranton, Pa., Oct. 11–13, 1939. At the summer convention, a paper will be given on ambient temperatures and weather conditions affecting the operation of electrical apparatus, and it is hoped that discussion will make available new information on weather conditions and temperatures characteristic of the western part of the country. At the Middle Eastern District meeting it is hoped to have papers dealing with the operating conditions met with in industry, and giving further information on the methods of testing and rating electrical machines.

The immediate objective of the committee is to review, and to modify where de-

sirable, the general principles on which temperature limits are based in rating electrical apparatus, so as to assure a continuing sound basis for the further development of the American system of electrical-apparatus rating.

Under this broad objective, the following specific proposals are suggested for consideration:

1. Determine whether recent investigations, service experience, or the trend of international standardization warrant any changes in the temperature limits of classes of insulation now covered.

2. Consider recent developments of new or improved insulating materials, and determine what changes, if any, should be made in AIEE Standards No. 1 to recognize adequately and limit properly the application of different insulations.

3. Review present practices and trends as to methods of temperature determination, and the conventional allowances associated with such methods; and, if desirable, make new provisions to accord with the modern trend to protected and enclosed types of apparatus.

4. Consider what fundamental provisions in the standards, if any, may be desirable, because of the more exacting methods of utilizing the inherent capacity of apparatus under various conditions of service, as now recognized in the AIEE Guide for Operation of Transformers.

The long-range objective is to establish a committee including experts familiar with rating problems in all types of apparatus, that will continuously maintain a watch over the principles of rating employed in the standards for the various types of apparatus, and will take whatever steps may be necessary to preserve proper co-ordination between these standards. While the question of temperature limits and methods of temperature measurement are of the first importance in this connection, as indicated, questions of standard units and nomenclature for measurement or description of torque, power, and other apparatus characteristics require consideration; and a broad plan for correlating the short-time or intermittent ratings of associated apparatus used in the same service is desirable.

For example, whatever temperature standards are adopted for rotating apparatus, they should be consistent with the ratings of control, wiring, fuses, and other associated equipment. It is proposed, therefore, that this committee deal with basic principles appearing in more than one standard, which have to do with questions of temperature and other factors involved in the output rating of apparatus. This does not include, however, questions of standard voltages, or insulation co-ordination, which will be handled by separate committees.

Current Items From American Engineering Council

Civil Service Seeks Advice From Profession

The President's Committee on Civil Service Improvement has authorized the appointment of a number of special advisory committees and Gano Dunn (A'91, F'12) a member of the President's Committee, with the assistance of officers of the National Academy of Sciences, the National Research Council and others, the American Engineering Council, the American Society of Civil Engineers and other leading engineering and technical societies, has appointed three such committees of five members each—one, covering the fields of mathematical, physical, and biological sciences, called for short, the science committee; a second, covering the fields of the general engineering societies consisting of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the Institute of Radio Engineers, which is known as the general engineering committee; and a third committee covering the fields of the specialized engineering societies, consisting in part of the American Society of Heating and Ventilating Engineers, the Society of Automotive Engineers, the American Society of Agricultural Engineers, the Illuminating Engineering Society, the American Society of Refrigerating Engineers and representatives of local and state engineering societies, to be known as the specialized engineering committee. The members of these three committees are as follows:

Science Committee

R. G. Harrison, *chairman*, chairman, National Research Council, care Yale University, New Haven, Conn.

J. A. Fleming, director, dept. of terrestrial magnetism, geophysical laboratory, Carnegie Institution of Washington, Washington, D. C.

L. J. Briggs, director, Bureau of Standards, Washington, D. C.

W. C. Mendenhall, director, Geological Survey, Washington, D. C.

Roger Adams, professor, organic chemistry, University of Illinois, Urbana.

General Engineering Committee

E. P. Goodrich, *chairman*, consulting engineer, chairman, committee on salaries, ASCE, 175 Fifth Avenue, New York, N. Y.

R. L. Sackett, chairman, committee on merit system, AEC, former vice-president, ASME, Hotel White, New York, N. Y.

S. D. Kirkpatrick, editor, *Chemical and Metallurgical Engineering*, 330 West 42nd Street, New York, N. Y.

W. B. Plank, head of department of mining engineering, Lafayette College, Easton, Pa.

O. W. Eshbach, Fellow, AIEE, Dean, Institute of Technology, Northwestern University, Evanston, Ill.

Specialized Engineering Committee

J. S. Dodds, *chairman*, vice-president, AEC, chairman, AEC committee on economic status of engineers, Box 207, Ames, Iowa.

S. P. Lyle, president, ASAE, Bureau of Agricultural Engineering, Department of Agriculture, Washington, D. C.

Thomas Urdahl, consulting engineer, chairman, admissions committee, ASHVE, 722 Jackson Place, N. W., Washington, D. C.

H. D. King, commissioner, Bureau of Lighthouses, Department of Commerce, Washington Society of Engineers, Washington, D. C.

H. T. Woolson, executive engineer, The Chrysler Corporation, past-president, SAE, Highland Park, Mich.

The memberships in these committees have been selected with reference to qualifications for formulating valuable opinion on civil service matters either through present or past employment in the government service, experience with merit systems in private industrial or educational fields, or demonstrated personal interest in and knowledge of the history and present problems of the civil service.

Federal Relations to Research

American Engineering Council over many years has interested itself in promotion of research as a fundamental and primary policy for the creation of new industries, the efficient improvement of technology, the increase of opportunities for employment, in general, the social and economic welfare of the nation. From time to time it has made specific fact-finding investigations.

This subject is actively before each Congress and the present Congress is no exception, several bills having been introduced in the House of Representatives. As would be natural, the main argument for government action in various directions for research this year rests upon the possibilities of increasing employment, since unemployment is a great national issue.

It is natural also that this subject should be approached from as many angles as the minds of the different authors of the bills suggest. Some of them tend to centralize and co-ordinate research into a sort of master agency of the Federal Government under whose sponsorship funds would be allocated in various ways both to government bureaus and semi-public agencies and to educational institutions. Such was the intent of H.R. 7939, the Randolph bill, so-called, proposed last year, on which no final action was taken.

Other bills, much more specific in character, concern themselves with the establishment of specific undertakings such as the four regional laboratories set up by last year's Congress under the direction of the Department of Agriculture for which $1,000,000 each was appropriated. Others are approached from the point of view that technology and the economic developments growing out of technology are responsible for the present unemployment. Suggestions have already been made to recommend the taxing of machinery as a method of balancing employment and technological advance.

In the preambles to the bills there is much confusion of terminology and much need for clarification of what is meant by the term research. Lyman J. Briggs, director of the National Bureau of Standards, in his leading discussion at the Detroit Forum of American Engineering Council on "Invention and the Engineer's Relation to It," suggests Julian Huxley's four categories of research. At one end is background re-

search, with no practical objective consciously in view as in the study of atomic physics. Next comes basic research, which must be quite fundamental in character but has some distant practical objective, such as the study of fluorescence; with the distant possibility of producing cold light. Third, there is *ad hoc* research with an immediate objective, such as research on discharge tubes for lighting purposes, and finally we have what industries call development or engineering research, which is the work needed to translate laboratory findings into full-scale commercial practice. As Huxley says, these categories overlap and interlock, but they form convenient pigeonholes.

American Engineering Council in early studies of this question has attempted to clarify, without official action, certain principles which may guide the authors of the many proposals to what seems to engineers to be the right relationship between the federal government and research. In these analyses it has seemed clear: (1) that the Federal Government may properly aid fundamental research in present federal bureaus and establishments; (2) that the Government may stimulate and assist research at educational institutions and such non-profit making laboratories as may be best prepared to serve the public; and (3) that these various aids should be so extended as not to interfere with private enterprise. Since it is obvious that the fundamental purpose of research can succeed practically so far as employment is concerned only when private industries individually accept this as a method of projecting new industry, the expansion of existing industry, the increase of employment in industry, and the steady distribution of the products of industry through reduction of cost.

The National Resources Committee has made several summaries of present projects but the committee approaches this total problem from the viewpoint of generalizing as to the values rather than projecting specific methods of accomplishment.

So far as the Federal Government is concerned these specific methods of accomplishment and the broader matter of philosophy outlined above take the form of bills introduced into Congress from the many points of view already indicated.

As pointed out by Doctor Briggs, the Federal Government is already spending several millions of dollars for research. It is evident, therefore, that we have a fact and not a theory.

The question then comes as to the practical methods whereby the Federal Government may by further grants of money extend the purposes and promote the fruits of research in terms of employment without confusion or duplication of effort. This is an enormously difficult question and most of the proposers of the various types of research legislation do not realize the complications and ramifications of their proposals.

Recent inquiries in informed governmental agencies seem to indicate that the present Congress is not disposed to add moneys to those already allocated to independent government agencies, semi-private non-profit institutions, or educational institutions, except on a 50-50 basis. It is moreover evident that any federal moneys must presuppose some federal control of those expenditures and here again there is confusion as to where this federal control should be placed. Of these newer proposals, according to one authority, the so-called Lea bill (H.R. 3652) comes closest to being in line with the principles stated above. However, there is doubt whether during this Congress any bills of this sort will reach actual consideration by vote.

One indication of this latter belief is found in the latest resolution on this subject (H. J. Res. 245) introduced in the House of Representatives on March 28 by Charles I. Faddis of Pennsylvania, in which a committee to be known as the Committee on Technological Unemployment is proposed; a sum of $200,000 is to be appropriated from the Treasury, of which $150,000 shall be available to the Secretary of Labor for the collection, preparation, and analysis of materials, and $50,000 for public hearings. It is proposed that the committee shall report its findings to the Congress on or before June 1, 1940. To date this joint resolution which must be passed by both the Senate and the House has not come to vote.

This whole subject needs leadership not now available, in part because of the diverse, sometimes competitive interests involved, and in part because the subject itself is so complex that it needs to be studied in the spirit made evident in certain findings of British commissions, with the intent of establishing a national policy for long-view objectives rather than piece-meal, confusing, and overlapping activities.

Future Meetings of Other Societies

Acoustical Society of America. Tenth-anniversary meeting, May 15–16, New York, N. Y.

American Association for the Advancement of Science. June 19–24, Milwaukee, Wis.

American Institute of Chemical Engineers. 31st semiannual meeting, May 15–17, Akron, Ohio.

American Institute of Mining and Metallurgical Engineers. 151st general meeting, July 10–13, San Francisco, Calif.

American Physical Society. 228th meeting, June 23–24, Princeton, N. J.

American Society for Testing Materials. 42d annual meeting, June 26–30, Atlantic City, N. J.

American Society of Civil Engineers. Annual convention, July 26–28, San Francisco, Calif.

American Society of Heating and Ventilating Engineers. Semiannual meeting, July 4–6, Mackinac Island, Mich.

American Society of Mechanical Engineers. Semiannual meeting, July 10–15, San Francisco, Calif.

American Society of Refrigerating Engineers. Spring meeting, May 21–22, Hershey, Pa.

Edison Electric Institute. Annual meeting, June 6–8, New York, N. Y.

Illuminating Engineering Society 33d annual convention, August 21–25, San Francisco, Calif.

Institute of Radio Engineers. National convention, June 27–30, San Francisco, Calif.

International Conference on Large High-Voltage Systems (CIGRE). Tenth meeting, June 29–July 8, Paris, France

National Electrical Manufacturers Association. May 14–18, Hot Springs, Va.

Society for the Promotion of Engineering Education 47th annual meeting, June 19–23, State College, Pa

Society of Automotive Engineers. World automotive engineering congress, May 22–28, New York, N. Y.; May 29–30, Indianapolis, Ind.; May 31–June 2, Detroit, Mich.; June 6–8, San Francisco, Calif.

Letters to the Editor

CONTRIBUTIONS to these columns are invited from Institute members and subscribers. They should be concise and may deal with technical papers, articles published in previous issues, or other subjects of some general interest and professional importance. ELECTRICAL ENGINEERING will endeavor to publish as many letters as possible, but of necessity reserves the right to publish them in whole or in part, or reject them entirely.

ALL letters submitted for consideration should be the original typewritten copy, double spaced. Any illustrations submitted should be in duplicate, one copy to be an inked drawing but without lettering, and the other to be lettered. Captions should be furnished for all illustrations.

STATEMENTS in these letters are expressly understood to be made by the writers; publication here in no wise constitutes endorsement or recognition by the American Institute of Electrical Engineers.

Utility Engineering and Capital

To the Editor:

C. W. Kellogg's excellent article in the January issue, "Utility Engineering and Capital," loses some of its force when the reader begins to look for his nonexistent comments on certain unethical practices in the public-utility field. When one apple in a barrel has a rotten spot the proper cure is to take that one from the barrel and cut out the rot. Setting out another orchard across the road from the first one, at the expense of the taxpayers, is not fair either to reliable growers or to the taxpayers, and trying to cure a few rotten spots by that means is hardly proof of a logical mind. Yet it seems hardly more logical to attack biased legislation with an article that also is biased.

A frank facing of the problem, admitting the bad spots as well as asserting honesty where honesty and ethical practice have obtained, should be a prime part of such a discussion as Mr. Kellogg's. Presenting only one side of a problem has never yet led to a satisfactory solution of that problem; witness the existing "yardstick" which finds its only justification in minds that refuse to think a problem through.

The holding company, an important target of present legislation, has a legitimate economic function under certain conditions; for a group of small operating companies the holding company can cut costs, especially financing costs, by an amount almost unbelievable. Although the fact that state authorities permit a public utility to earn a specified return on all money spent for plant or betterments has led to the loading of costs in some instances, yet the practice of having one engineering company serve all plants in a given holding company is normally legitimate because it maintains proper standards at a minimum engineering cost. Ignoring or concealing the malpractice of a company or two in this matter is covering up the rotten spots and leaving the bad apples in the barrel to contaminate the sound ones. When visionaries are looking for excuses to push through their unsound schemes, such concealment is playing into the hands of the enemy.

We do not need to name the guilty companies, nor need we list all the specific abuses in the public-utility field.

What incentive has any company to continue its policy of honesty when foes attack all companies indiscriminately and friends whitewash the dishonest ones? What return can we expect from a defending article in a journal when watered valuations of actual physical plant and equipment sweep away its basic premise?

May we have another article, one that will admit all facts, face them, and suggest proper remedies for bad practice, in that way fighting the "yardstick" falsification with complete facts instead of with the "yardstick's" own method of partial concealment of fact?

Very truly yours,
H. H. KETCHAM (A'13, M'23)

(8 West Church Street, Bethlehem, Pa.)

Representations of the Synchronous Machine

To the Editor:

Some years ago I constructed and exhibited at Columbia University a simple mechanical device in which the relation between root-mean-square bus voltage e, short-circuit root-mean-square current i_s, transformed power p, and rotor angle ψ of a synchronous motor is represented in a novel and instructive way.

The device is shown in figure 1 and is diagrammed in figure 2 and represents Hopkinson's fundamental formula

$$p + i_s^2 r = e i_s \sin(\psi + \tan^{-1} r/\omega l) \qquad (1)$$

where r is the armature resistance and ωl the synchronous reactance for a round-rotor machine.

For a given excitation $i_s^2 r$ is a constant and is represented by a weight w while the power transformed p is represented by a weight W. Taking the radius of the pulley as unity and multiplying both sides of (1) by this unit, an equation in moments is obtained in which the clockwise moment is the weight A multiplied by $a \sin(\psi + \alpha)$ where $\alpha = \tan^{-1} r/\omega l$. To represent (1), let either A be the bus voltage in suitable units and the arm a the short-circuit root-mean-square current of the armature, or vice versa; the question of calibration of the arm a and of the mass-to-electrical units ratio for A being simple matters in either case. A right-hand pan is

Figure 1

provided for the weight W when the machine is acting as a generator, that is, when p is negative. The weight w remains always in the left or motor pan.

At the pull-out motor load, $\psi + \alpha \geq \pi/2$ and the instrument becomes unstable and pulls out of balance. The phenomenon of a synchronous generator losing step with an infinite bus can be similarly exhibited. The phenomena of over-swing without loss of synchronism, or with only temporary loss of synchronism, resulting from sudden changes in load or bus voltage in the case of the synchronous motor have their dynamical analogies in the behavior of the device; parallelism in transient behavior between the two will be practically exact when the damping forces are the same.

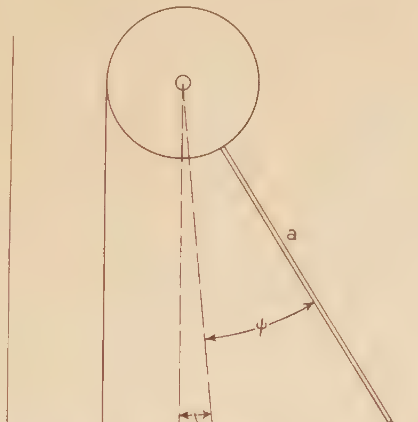


Figure 2

Systems of synchronous machines may be represented by systems of these pendulum devices when certain servo mechanisms are provided. Also the device may be modified to take saliency accurately into account.

As shown in figure 3, the locus of p as a function of ψ is a limaçon and the locus of p', the synchronizing power, is a circle whose diameter ei_s is the diameter of the

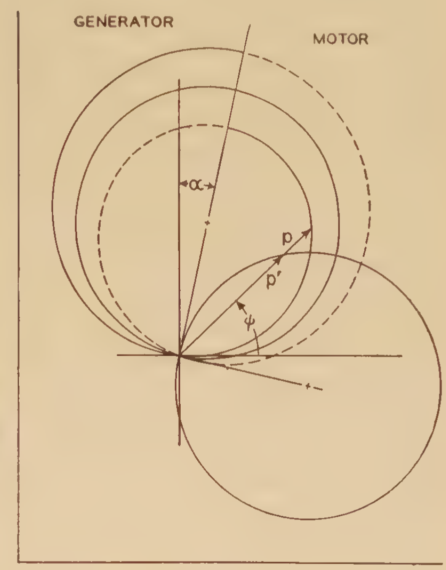


Figure 3

base circle of the limaçon. It is seen that p' decreases as p increases and becomes zero at pull-out and that p' is a maximum when p is zero, etc.

Very truly yours,
W. H. INGRAM

(New York, N. Y.; Member, American Mathematical Society)

Kirchoff's Equations in a Many-Dimensional Representative Space

To the Editor:

In line with the recent interest among the AIEE members in purely analytical modes of representation of electric-circuit relationships, using matrix algebra and tensor analysis, a geometrical interpretation of simultaneous linear equations may be opportune. A passive linear electric network is usually represented by such equations which express the two Kirchoff laws. Consider n simultaneous equations of the form

$$a_{1j}x_1 + a_{2j}x_2 + \ldots + a_{mj}x_m = b_j \qquad (1)$$

where j has all the integral values from 1 to n, and where in the general case m is not equal to n. The coefficients a may be real or complex numbers, or operational expressions containing derivatives with respect to time. By interpreting this system of equations, its determinants, and minors in terms of super-vectors and super-parallelopipeds in a many-dimensional

representative space, a new and different point of view is obtained, which may prove to be fruitful to the researcher and the student of the future.

We shall illustrate first, geometrically, the familiar case of $m = 3$, $n = 2$, and put the two b's equal to zero. This will give

$$\left.\begin{aligned} a_{11}x_1 + a_{21}x_2 + a_{31}x_3 = 0 \\ a_{12}x_1 + a_{22}x_2 + a_{32}x_3 = 0 \end{aligned}\right\} \qquad (2)$$

Take the usual Cartesian system of three-dimensional orthogonal co-ordinate axes, X_1, X_2, X_3, and let x_1, x_2, x_3, be the projections of an unknown vector R upon these axes. Similarly, let a_{11}, a_{21}, a_{31} be the corresponding projections of a known vector A_1, and a_{12}, a_{22}, a_{32} those of another known vector A_2. In terms of vector analysis, the first equation (2) simply expresses the condition $A.R = 0$, that is, the unknown vector R is normal to A_1. The second equation states that R is also perpendicular to A_2. Hence, R is perpendicular to the plane formed by A_1 and A_2. Any two other lines in the plane A_1A_2 will define the same direction R. Thus, it will be seen that two homogeneous linear equations with three unknowns admit of a simple geometrical interpretation in a three-dimensional space.

Any point on R determines a set of quantities x_1, x_2, x_3, which satisfy equations (2). This agrees with the fact that these equations are sufficient to determine only the ratios, such as x_1/x_3 and x_2/x_3, but not the unknowns themselves. Thus, instead of thinking analytically of equations (2), one need only imagine a plane determined by the given parameters a, and a direction normal to this plane. For example, let all the a's be ohmic resistances, and x_1, x_2, x_3, some unknown electric currents. In a representative three-dimensional space these resistances, or their equivalents, will form a plane, and R is a direction normal to this plane. Any point on R gives the values of the three unknown currents which satisfy the given Kirchoff equations. Incidentally, the same plane may be determined by an infinite number of pairs of vectors A or equations (2); this may be of interest to those engineers who are working on equivalent networks or transformation of networks.

Extending this geometric interpretation to a system of n homogeneous equations with $n + 1$ unknown quantities (all the b's still being equal to zero), the following proposition may be stated:

Proposition I. The n given sets of coefficients a determine n super-vectors in a representative $(n + 1)$ dimensional Euclidean space, and thus define an n-dimensional sub-space. The super-vector R of the $n + 1$ unknown quantities is normal to this sub-space.

In our ordinary space a line can be perpendicular only to another line or to a plane. In an N-dimensional space, an $N - q$ dimensional sub-space may be perpendicular to another sub-space of any number of dimensions, up to q. As a specific case above, a straight line may be normal to an $N-1$ dimensional sub-space. This means that the line is normal to any straight line lying within that sub-space.

Let now the number of homogeneous equations to which Proposition I refers be increased to $(n + 1)$. If the $n + 1$ vectors A form a space of $n + 1$ dimensions, a finite R perpendicular to it does not exist, and the only possible solution is $R = 0$. If a sub-space exists, of n or less dimensions, then at least one of the given equations is superfluous, and merely indicates that the $n + 1$ vectors A are not independent of one another. The reader can readily see this in the three-dimensional case: the three vectors A must be co-planar, and any of them may be linearly composed of the other two.

In a more general system of nonhomogeneous equations (1) when all the b's are not equal to zero, consider again the three-dimensional case first ($n = m = 3$). The familiar solution for x_1 is

$$x_1 = (b_1m_1 + b_2m_2 + b_3m_3)/D,$$

where D is the determinant formed of the a's, and the m's are its three cofactors not containing the coefficients of x_1. But it is known from vector analysis that D is the volume of a parallelopiped built on the vectors $A_1A_2A_3$. Similarly, $b_1m_1 + b_2m_2 + b_3m_3$ is the volume of the parallelopiped built on B, A_2, A_3, where B is the vector whose components are b_1, b_2, b_3. Thus, the given system of three equations admits of the following geometric interpretation: Imagine four parallelopipeds constructed on the vectors A_1, A_2, A_3, B, taken three at a time. Let their volumes be D, D_1, D_2, D_3, respectively. Then

$$x_1 = D_1/D; \quad x_2 = D_2/D; \quad x_3 = D_3/D \qquad (3)$$

This solution fails when $D = 0$, that is, when the three A's happen to be co-planar. In this case the equations are inconsistent with each other.

Proposition II. When there are n simultaneous nonhomogeneous equations, the equations (3) may be generalized and interpreted geometrically in an n-dimensional representative space, using n-dimensional super-parallelopipeds. It is shown in many-dimensional geometry that their volume is also numerically equal to the corresponding determinants built of the projections of their edges, $A_1\, A_2, \ldots, A_n$. The $(n + 1)$st vector, B, consists of the components $b_1, b_2, \ldots, b_n$.

Another possible interpretation of equation (1) for $m = n$ consists in replacing x_1 by y_1/y_{n+1}, x_2 by y_2/y_{n+1},etc., where y_{n+1} must not be equal to zero. After multiplication of each equation by y_{n+1}, a system of n homogeneous equations with $n + 1$ unknown quantities is obtained.

Proposition III. In an $(n + 1)$ dimensional space an n-dimensional sub-space exists, formed by the vectors of the coefficients of the given n equations; there also exists a vector R normal to this sub-space. Any point on R gives a set of values of the unknowns y which satisfy the transformed equations. The point on R for which $y_{n+1} = 1$ has for its other projections the values of the x's in the given equations.

Consider again our three-dimensional space and some three vectors in it, A, B, C, which determine a parallelopiped. In the vector-analysis notation, the volume of this parallelopiped is $(A \times B)$. C, where

$$A \times B = (a_2b_3 - a_3b_2)i + (a_3b_1 - a_1b_3)j + (a_1b_2 - a_2b_1)k \qquad (4)$$

where i, j, k, are unit vectors along the three axes, respectively. This expression represents the area of the base AB of the parallelopiped ABC. The three areas within the parentheses in equation (4) are the projections of the base AB upon the co-ordinate planes YZ, ZX, and XY, respectively. The same expressions are three of the minors of the determinant consisting of the nine projections of the vectors A, B, C. The dot and the cross in the expression $(A \times B).C$ are interchangeable, and so are the letters themselves, so long as their cyclic order is preserved. Thus, we have the following relationship in a three-dimensional space: Any three non-co-planar vectors form a parallelopiped whose volume is numerically equal to the determinant formed of the projections of these vectors. The first minors of this determinant are numerically equal to the projections of the corresponding base of the parallelopiped upon the three co-ordinate planes. With a suitable convention as to the order of the vectors, the signs of the analytical expressions can be made to agree with those of their geometrical equivalents.

When extending this relationship to more than three simultaneous equations, that is, to many-dimensional spaces, it is necessary to keep in mind the number of co-ordinate sub-spaces of different orders. In an n-dimensional space there can be imagined n axes of co-ordinates at right angles to each other. Any k of these will form a co-ordinate sub-space of order k. The number of combinations of n objects taken k at a time is

$$_kC_n = n(n - 1) \ldots (n - k + 1)/k!$$

This is the number of co-ordinate sub-spaces of order k. The following table gives a few common values of $_kC_n$.

n	$k = 1$	$k = 2$	$k = 3$	$k = 4$
3	3	3		
4	4	6	4	
5	5	10	10	5

It will be readily seen that these values are those of the non-extreme coefficients in a binomial expansion. For example:

$$(x + 1)^4 = x^4 + 4x^3 + 6x^2 + 4x + 1$$

Thus, in a four-dimensional space there are four co-ordinate axes, six co-ordinate planes, and four three-dimensional co-ordinate sub-spaces. When projecting a four-dimensional super-parallelopiped on such co-ordinate sub-spaces, it is necessary to specify the number of dimensions used. For example, an edge of a four-dimensional super-parallelopiped may be projected upon the four axes, upon the six planes, or upon the four three-dimensional sub-spaces. Each side of the super-parallelopiped may be projected either upon the six co-ordinate planes or upon the four co-ordinate bodies. Each of the eight three-dimensional bodies delimiting the super-parallelopiped may be projected upon any of the four co-ordinate bodies. As the number of space dimensions increases, the possible number of projections also increases quite rapidly.

Proposition IV. In a space of any number of dimensions, n, the volume of a super-parallelopiped is numerically equal to the determinant made of the projections

of the vectors which form the edges of this parallelopiped. If the vectors are not independent of one another but form a subspace of not more than $n - 1$ dimensions, the volume of the super-parallelopiped is zero, and so is the value of the determinant.

Proposition V. A set of minors of any order k gives the numerical values of the projections of the k-dimensional members of the parallelopiped upon the co-ordinate bodies of that number of dimensions. A Laplace's development of the determinant by the k and $n - k$ rows may be geometrically interpreted as the volume of the super-parallelopiped expressed as the scalar product of its kth and $(n - k)$th elements. In the simplest case, the volume of an ordinary three-dimensional parallelopiped is equal to a scalar product of its base $A \times B$ and the third edge C. Here $A \times B$ is to be thought of as a vector normal to the plane AB.

It is hoped that these propositions, given here without proofs, may stimulate younger scientifically inclined electrical engineers to study n-dimensional spaces, with the idea of using them as representative spaces in advanced circuit problems and other pioneer investigations in our profession. Such a mode of representation has been found valuable, for example, in statistical mechanics of large aggregates of particles.

Very truly yours,

Vladimir Karapetoff (A'03, F'12)

(Consulting Engineer, Professor of Electrical Engineering, Cornell University, Ithaca, N. Y.)

Personal Items

O. W. Eshbach (A'17, F'37) has been appointed dean of the new Institute of Technology at Northwestern University, Evanston, Ill. Born in Pennsburg, Pa., 1893, he graduated from Lehigh University in 1915 with the degree of electrical engineer. During the next year he was an assistant to the chief engineer at the United States Naval Engineering Experiment Station, Annapolis, Md., where he also spent the summer of 1917. He entered the United States Army in November 1917, serving as a second lieutenant in the Signal Corps and a radio instructor for officer candidates. In 1919 he returned to Lehigh University, where he had been an instructor in electrical engineering and a graduate student in 1916 and 1917, and continued in both capacities, receiving the degree of master of science and promotion to an assistant professorship in 1920. In 1923 he became assistant engineer for the Bell Telephone Company of Pennsylvania, Philadelphia, engaged in college relations and student training, and in 1925 was employed in a similar capacity as special assistant in the personnel department, American Telephone and Telegraph Company, New York, N. Y. In that position, where he continued until his recent appointment, he was supervisor of the Bell System option of Massachusetts Institute of Technology co-operative course in electrical engineering and non-resident instructor at MIT; he also served as instructor in the night graduate school of electrical engineering of Brooklyn (N. Y.) Polytechnic Institute. He was editor-in-chief of "Handbook of Engineering Fundamentals" published by John Wiley and Sons, New York, 1936. He is a member of the AIEE publication committee and of the committee on education (chairman, 1935–7) and has been active on several other committees. He is also a member of the Society for the Promotion of Engineering Education, the Engineers' Council for Professional Development, Sigma Xi, and Eta Kappa Nu.

O. W. ESHBACH

H. B. Brooks (A'09, F'31) retired February 1, 1939, as physicist and chief of the electrical instrument section of the National Bureau of Standards, Washington, D. C. Born in 1869 in New Bremen, Ohio, Mr. Brooks was employed by the Edison Electric Illuminating Company of Piqua, Ohio, in 1886, and the following year, after three months in the testing room of the Edison Machine Works at Schenectady, N. Y. (forerunner of the General Electric Company), he was made superintendent and electrician of the plant. He resigned in 1898 to attend Ohio State University, where he received the degree of mechanical engineer in electrical engineering in 1903, having served as student assistant both in physics and in electrical engineering during his course. Upon graduation he became a laboratory assistant in the Bureau of Standards, advancing through various grades to the position he held at retirement. He was the first chief of the electrical-instrument section, assuming the position in 1906. He received the degree of doctor of philosophy from Johns Hopkins University in 1926, for work in electrical engineering. Since 1919 he has been a member of the Institute's committee on instruments and measurements, taking an active part in the establishment of standards. He is the author of many papers on technical subjects.

R. H. Burcher (A'19, M'20) plant operation engineer in the department of operation and engineering, American Telephone and Telegraph Company, New York, N. Y., retired March 21, 1939, on the 39th anniversary of his employment in the Bell System. A native (1878) of Dunkirk, N. Y., Mr. Burcher attended the State Normal School at Fredonia, N. Y., and in 1900 was employed in outside-plant work by what was then the New York and New Jersey Telephone Company. He was appointed division plant engineer for the Long Island division of the New York Telephone Company in 1907, and division construction superintendent in 1912. In 1914 and 1915 he was engaged in inventory and appraisal work on rate-making cases for Bell Telephone properties in Pennsylvania and New York, and in 1915 joined the general engineering staff of the American Telephone and Telegraph Company, becoming plant operating methods engineer in 1917 and outside plant engineer in 1919. He was appointed an assistant vice-president in 1920, and in 1927 assumed the position of plant operation engineer, which he held until retirement.

H. S. Osborne (A'10, F'21) has been appointed operating results engineer in the department of operation and engineering, American Telephone and Telegraph Company, New York, N. Y. A native (1887) of Fayetteville, N. Y., Doctor Osborne received the degree of bachelor of science in electrical engineering in 1908, and that of doctor of engineering in 1910 from Massachusetts Institute of Technology. He entered the engineering department of the American Telephone and Telegraph Company in 1910, and became assistant to the transmission and protection engineer in 1914. From 1920 until his recent appointment he was transmission engineer. Doctor Osborne is a director of the Institute, chairman of the technical program and award of Institute prizes committees, and member of several other Institute committees. He is also active in other technical societies, and is the author of many articles on technical subjects.

H. S. OSBORNE

J. D. Preston (M'37) has been made general manager of the Cliffs Power and Light Company, Ishpeming, Mich. A native (1898) of Paris, Tex., Mr. Preston was graduated

L. G. WOODFORD

J. R. SHEA

J. D. PRESTON

Bachrach

A. L. COOK

R. H. KNOWLTON

from the University of Texas in 1921 with the degree of bachelor of science in electrical engineering, and received the degree of master of science in electrical engineering from Massachusetts Institute of Technology in 1923. While working for the latter degree, he was an assistant instructor in the department of electrical engineering at MIT. In 1923 and 1924 he was a student engineer with the Texas Construction Company at Dallas, Tex., and for the following two years he was an engineer for the Cia Cubana de Electricidad, Inc., Havana, Cuba. In 1926 he became superintendent of distribution for the Central Power and Light Company, San Antonio, Tex., and in 1929 superintendent of the electrical department of the Columbus, Delaware, and Marion Electric Company, Marion, Ohio. He was employed in the engineering department of the Florida Power and Light Company at Miami in 1933 and the following year became head of the rate department, continuing in that position until his recent appointment.

J. R. Shea (M'30) has been appointed manager of the Point Breeze works of the Western Electric Company at Baltimore, Md. Born at Fiske, Wis., in 1886, Mr. Shea received the degree of bachelor of science in electrical engineering at the University of Wisconsin in 1909. He entered the student course at the Hawthorne works of Western Electric, Chicago, Ill., the same year, and has continued with the company ever since. He became chief of production branch methods at the Hawthorne works in 1915. In 1918 he went to the Orient as advisor on manufacturing methods to the Nippon Electric Company, Tokyo, Japan, and the China Electric Company, Shanghai, returning to the United States in 1919 to become assistant division chief in the technical branch at Hawthorne. He was made assistant superintendent of development in 1922, and superintendent of manufacturing development in 1927. From 1929 until his present appointment he was assistant engineer of manufacture at the company's Kearny, N. J., works.

J. B. Harris, Jr. (A'17) has been appointed vice-president of the Rumsey Electric Company, Philadelphia, Pa. Born March 7, 1890, at Hinton, W. Va., he graduated from Bliss Electrical School, Washington, D. C., in 1911. He was associated as a sales engineer with General Electric Company, Westinghouse Electric and Manufacturing Company, and the Pittsburgh Transformer Company, Pittsburgh, Pa., later becoming a field engineer for the last-named company. In 1920 he became a member of the firm of Harris and Evans, Philadelphia, Pa., which later became Harris and Butler. Mr. Harris became president of the latter firm, continuing in this position until 1935, when he was made manager of the electrical-equipment department of the Rumsey Electric Company. He held that position until his present promotion. He is a junior past chairman, AIEE Philadelphia Section.

A. L. Cook (A'02, M'13) has been appointed director of the school of science and engineering at Pratt Institute, Brooklyn, N. Y. He has been acting director since May 1938, and for 25 years before was head of the electrical-engineering department of the school. A biographical sketch of Mr. Cook appeared in the July 1938 issue (pages 320–1) when he assumed the acting directorship of the school.

L. G. Woodford (M'31) has been appointed plant operation engineer in the department of operation and engineering of the American Telephone and Telegraph Company, New York, N. Y. Born in Waterloo, Iowa, in 1888, he studied mining engineering at Iowa State College and was employed by the Iowa Telephone Company, Des Moines, in 1911, becoming appraisal engineer in 1914. In 1916 he was employed as an appraisal engineer by the Northwestern Bell Telephone Company, Omaha, Nebr., and five years later became engineer of costs and practices for that company. He came to the American Telephone and Telegraph Company in 1923, becoming plant inventory and costs engineer in 1927, plant extension engineer in 1933, and in 1935 operating results engineer, the position he held until his recent promotion.

R. H. Knowlton (A'12) has been made executive vice-president and general manager of the Connecticut Light and Power Company, Hartford, Conn. A native (1882) of Trenton, N. Y., Mr. Knowlton graduated in civil engineering at Cornell University in 1906. Employed 1907–09 by Standard Electric Construction Company, Rochester, N. Y., and 1909–10 by General Electric Company, Cincinnati, Ohio, in 1910 he became a salesman of industrial power for the United Gas Improvement Company, Philadelphia, Pa. He was later appointed industrial engineer, then power engineer, and finally assistant to the vice-president of that company. He joined the Connecticut Light and Power Company in 1926 as assistant to the president, becoming a vice-president the following year.

C. E. Ide (A'16, M'38) recently was elected president of the Southeastern Electric Exchange. Mr. Ide has been vice-president and general manager of the East Tennessee Light and Power Company, Bristol, since 1927 and has held the same position in the Tennessee Eastern Electric Company, also at Bristol, since 1928. After graduating from Iowa State College in 1914 with the degree of bachelor of science in electrical engineering, he was employed in engineering capacities by utility companies in Denver, Colo., Toledo, Ohio, and Meridian, Miss., and as statistical engineer by Henry L. Doherty and Company, New York, N. Y In 1919 he became assistant electrical engineer for the latter company, and in 1922 assistant to the chief engineer in charge of public utility operations, remaining in that position until 1927.

Glen Ireland (M'31) has been appointed transmission engineer by the American Telephone and Telegraph Company, New York, N. Y. After graduating from the University of Iowa in 1917 with the degree of bachelor of science in electrical engineering, Mr. Ireland spent two years in the United States Army as radio and telephone officer. He then became a telephone engineer for Northwestern Bell Telephone Company, Des Moines, Iowa, and in 1923 entered the plant engineering division of the department of operation and engineering, American Telephone and Telegraph Company. Before his recent appointment he was engineer in charge of the maintenance group in the plant engineering division.

R. B. McKinley (A'27) has been appointed service engineer for the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. He will be located with the Westinghouse staff at the New York World's Fair at present. Mr. McKinley was formerly design engineer in the electrical-engineering department of the Union Switch and Signal Company, Swissvale, Pa.

L. M. Robertson (A'27) has been appointed chairman of the engineering section of the

Rocky Mountain Electrical League for 1939. He is transmission and station engineer for the Public Service Company of Colorado, with headquarters at Denver.

T. W. Swartz (A'35) has been made superintendent of the underground department of the Hawaiian Electric Company, Honolulu. He was formerly assistant superintendent, underground department, Northwestern Electric Company, Portland, Ore.

W. H. McKinley (A'37) has been made second vice-president of the Electric Club of San Diego, Calif., and chairman of its membership committee. He is chief electrician of the City of San Diego.

E. E. Shaffer (A'37) has been elected a director of the Electric Club of San Diego, Calif. He is electrical inspector for the City of San Diego.

Obituary

Clarence Floyd Hirshfeld (A'08, F'36) died in Detroit, Mich., April 19, 1939. He was chief of the department of research of The Detroit Edison Company. Born January 30, 1881, at San Francisco, Calif., he received the degrees of bachelor of science in electrical engineering from the University of California in 1902, master of science in mechanical engineering from Cornell University in 1905, and the honorary degree of doctor of engineering from Rensselaer Polytechnic Institute in 1932 and from the University of Detroit in 1938. He became an instructor at Cornell University, Ithaca, N. Y., in 1903, later becoming assistant professor and professor of mechanical engineering. During this period and later he carried on engineering consultant practice. In 1914 he was appointed by the Detroit Edison Company to the position of chief of the research department which he held for the rest of his life. He organized the department, one of the first established by an electricity supply company. During the World War he was a lieutenant-colonel in the United States Army Ordnance Department. He was chairman of the Engineers' Council for Professional Development from its organization until 1935, and at the time of his death was president of Utilities Co-ordinated Research, Inc., an organization formed by a group of electric utility companies. He was a member of many technical societies, author of several books and many articles on technical subjects, and had served on the AIEE committees on power generation, standards, and electrical machinery. In 1937 he was awarded the Worcester Reed Warner Medal of The American Society of Mechanical Engineers.

William Amzi Dick (A'02, M'04, F'13) retired, died at Wilkinsburg, Pa., December 5, 1938, according to information recently received. Associated for 43 years with the Westinghouse Electric and Manufacturing Company, Mr. Dick made valuable contributions to the electrical industry in the design of d-c motors. He was born September 19, 1866, at Geneva, Ohio, and received the degree of bachelor of arts at Oberlin College in 1890 and that of mechanical engineer in electrical engineering from Cornell University in 1892. Following graduation he entered the student course of the Westinghouse Company, then at Pittsburgh, Pa., becoming inspector of the detail department the same year. In 1895, about the time the company moved to East Pittsburgh, Pa., he became foreman of the detail testing department and in 1898 engineering correspondent of the engineering department. He was transferred in 1899 to the Walker Company, Cleveland, Ohio, a subsidiary of the Westinghouse Company, as electrical engineer in charge of electrical and mechanical design, returning to East Pittsburgh in 1901 as designer of d-c machines. In 1912 he was appointed an application and sales engineer. In 1924 he became superintendent of extension courses, developing courses relating to the electrical industry for the use of employees and others. He continued in that position until his retirement in 1935. In addition to the courses of study, Mr. Dick was the author of papers on technical subjects and other writings on the electrical industry. He was the first chairman (1922–23) of the AIEE Springfield, Mass., Section.

Thomas Alfred Panter (A'03, M'13, F'26) engineer in charge of operations of the Bureau of Power and Light, City of Los Angeles, Calif., died March 12, 1939. He was born in Manchester, England, September 29, 1876, and studied electrical engineering at Ohio State University, leaving during his fourth year because of ill health. From 1902 to 1905 he was engineering assistant to the superintendent, Niagara Falls (N. Y.) Power Company. In 1905 he was employed by the Pacific Light and Power Company, Los Angeles, Calif.; during the following year he was superintendent of the Ontario (Calif.) Power Company, but in 1907 he returned to the former company. In 1908 he began design and engineering work in connection with the Los Angeles aqueduct, and from 1910 to 1916 was engaged in design and construction for the Los Angeles municipal power system. With the organization of the city's Bureau of Power and Light in 1916, Mr. Panter was made engineer in charge of operations, a position he held until his death, acting also as chairman of the advisory committee for the Bureau. In 1935 he spent some time in Washington, D. C., serving as an advisor on the organization of the United States Rural Electrification Administration. He was appointed in 1938 chief engineer to the special joint Congressional committee investigating the Tennessee Valley Authority, and had submitted his report only a short time before his death.

Charles Benjamin Coates (A'03, M'13) electrical engineer, Chicago Pneumatic Tool Company, Cleveland, Ohio, died March 17, 1939. Mr. Coates was born January 4, 1870, at Erie, Pa., was educated there, and spent four years (1887–91) as an apprentice machinist with the Bay State Iron Works of Erie. From 1891 to 1894 he was a journeyman machinist for the Keystone Electric Company in the same city. The years 1894 to 1896 were spent studying mathematics and physics at Syracuse University, and electrical engineering at Cornell University. In 1896 he became chief draftsman for the Keystone Electric Company at Erie, in 1900 superintendent, and in 1902 electrical engineer. Several years later he was employed as electrical engineer by the Chicago Pneumatic Tool Company, Chicago, Ill., and continued with that company as manager of the electrical department first in Chicago, later in Erie, Pa., and as chief electrical engineer in Erie and in Cleveland, Ohio, until his death.

Royal R. Crates (A'37) chief of underground division, Light and Water Commission of the City of Memphis, Tenn., died March 10, 1939, in Fort Wayne, Ind. Mr. Crates was born at Monroeville, Ind., January 10, 1900, and graduated from Purdue University, Lafayette, Ind., in 1922, with the degree of bachelor of science in electrical engineering. From 1922 to 1924 he was employed as an engineer in the electrical distribution department of Consumers Power Company, at Jackson, Mich., and 1924–27 as assistant distribution engineer in charge of underground distribution for the operating companies of the Commonwealth Power Corporation. In 1927 he became division engineer for Consumers Power Company at Kalamazoo, Mich., continuing in that position until 1936, when he entered the employ of the City of Memphis Light and Water Commission as assistant chief engineer of the lighting division, later assuming the position which he held at the time of his death.

John Edmund Cammack (A'19), assistant engineer, Potomac Electric Power Company, Washington, D. C., died in March 1939. He was born April 12, 1889, in Washington, D. C. He attended Mount St. Mary's College, Emmitsburg, Md., receiving the degrees of bachelor of arts in 1911 and master of arts in 1914, and studied engineering at the Catholic University of America, Washington, receiving the degree of bachelor of science in electrical engineering in 1916. During the World War he did radio and telephone work in the Signal Corps of the United States Army. After discharge from the Army, he was employed in the electrical-engineering department of the Potomac Electric Power Company, where he remained, as junior engineer, and later as assistant engineer, until his death.

Edgar Strasburger (A'03) died recently at White Plains, N. Y. Born in New York, N. Y., March 21, 1873, Mr. Strasburger received the degree of bachelor of science at the College of the City of New York in 1894 and the degree of electrical engineer in mechanical engineering at Cornell University in 1896. He became an assistant in the cable department of Western Electric Company, New York, in 1896, and later was made superintendent of the company's cable department in London, England. In 1916 he was appointed general superintendent of the Standard Underground Cable Company, Ltd., at Hamilton, Ont., Canada, and some years later became works manager of The Standard Underground Cable Company, St. Louis, Mo.

Membership

Recommended for Transfer

The board of examiners, at its meeting on April 20, 1939, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the national secretary.

To Grade of Fellow

Blume, L. F., assistant engineer, General Electric Company, Pittsfield, Mass.
DeBeech, A. V., electrical engineer, Canadian and General Finance Company, Ltd., Toronto, Can.
Tucker, C. E., professor of electrical engineering, Massachusetts Institute of Technology, Cambridge.
Warner, R. W., professor of electrical engineering, University of Texas, Austin.

4 to Grade of Fellow

To Grade of Member

Allen, J. E., chief of tests, Pennsylvania Water and Power Company, Baltimore, Md.
Anderson, J. W., engineer, system planning, Philadelphia Electric Company, Philadelphia, Pa.
Diehl, C. W., general foreman, Westinghouse Electric and Manufacturing Company, Sharon, Pa.
Eells, M. M., vice-president, in charge of engineering, Breeze Corporations, Inc., Newark, N. J.
Farrow, A. P., acting electrical engineer, Knoxville Electric Power and Water Board, Knoxville, Tenn.
Fergg, W. F., engineering inspector, Consolidated Edison Company of N. Y., Inc., New York, N. Y.
Flegal, B. C., division electrical superintendent, Oklahoma Gas and Electric Company, Enid.
Fochs, H. N., assistant electrical engineer, Gibbs and Cox, Inc., New York, N. Y.
Housley, J. E., superintendent of power, Aluminum Company of America, Alcoa, Tenn.
Leonard, C. E., senior switchman, Illinois Bell Telephone Company, Urbana.
McDonald, J. A., superintendent of service shop, General Electric Company, Salt Lake City, Utah.
O'Brien, J. E., assistant professor of electrical engineering, The Catholic University of America, Washington, D. C.
Olmsted, L. M., division engineer, Duquesne Light Company, Pittsburgh, Pa.
Perry, L. P., consulting engineer, St. Petersburg, Fla.
Rockey, C. H., superintendent, Municipal Utilities, Alliance, Nebr.
Stevens, W. P., chief engineer, Wm. G. Morrison, Waco, Tex.
Stewart, H. R., protection engineer, New England Power Service Company, Boston, Mass.
Tchinnis, P. M., chief engineer, Samson United Corporation, Rochester, N. Y.
Thomas, C. U., operating supervisor, Duquesne Light Company, Pittsburgh, Pa.
Thomson, L. P., maintenance superintendent, Ducilo S. A. Productora de Rayon, Argentina, South America.
Whitehead, E. R., supervisor, Duquesne Light Company, Pittsburgh, Pa.
Wyland, E. E., general plant supervisor, Mountain States Telegraph and Telephone Company, Denver, Colo.
Young, F. E., sales engineer, Westinghouse Electric Supply Company, Salt Lake City, Utah.

23 to Grade of Member

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the national secretary before May 31, 1939, or July 31, 1939, if the applicant resides outside of the United States or Canada:

United States and Canada

Baldwin, D. R., Aluminum Company of America, Alcoa, Tenn.
Ballin, A. E. (Member), 2005 Philtower Building, Tulsa, Okla.
Barnes, C. O., Southwestern Bell Telephone Company, Tulsa, Okla.
Barr, R. R., 261 Emerson St., Pittsburgh, Pa.
Brooks, C. R., Aluminum Company of America, Alcoa, Tenn.
Bruckman, W. C., Westinghouse Electric and Manufacturing Company, Mansfield, Ohio.
Byars, L. T. (Member), Union Electric Company of Missouri, St. Louis.
Cambridge, C. G., Signal Corps Laboratories, Fort Monmouth, Oceanport, N. J.
Carver, L. A., Works Progress Administration, Trenton, N. J.
Corbett, C. W., WBO Broadcasting Corporation, New York, N. Y.
Cross, J. W. (Member), Memphis Power and Light Company, Memphis, Tenn.
Dee, E. L. (Member), General Electric Company, Salt Lake City, Utah.
Deming, J. W., Memphis Light, Gas, and Water Division, Memphis, Tenn.
Dempwolf, C. J., Carlile and Doughty, Inc., Conshohocken, Pa.
Denton, S. M., United States Bureau of Reclamation, Denver, Colo.
Denyer, A. G., Southern California Edison Company, Ltd., Alhambra, Calif.
Dickerson, H. A., Jr., American Steel and Wire Company, Donora, Pa.
Donovan, J. D., Board of Public Utilities, Kansas City, Kans.
Doolittle, R. C., Jr., Maquoketa Valley Rural Electric Cooperative, Anamosa, Iowa.
Dunham, A. W., Anaconda Wire and Cable Company, Denver, Colo.
Farquhar, W. N., Aluminum Company of America, Massena, N. Y.
Few, W., General Electric Company, Fort Wayne, Ind.
Frankl, P. W., Continental Electric Company, Newark, N. J.
French, S. F. (Member), Anaconda Copper Mining Company, Hastings-on-Hudson, N. Y.
Frey, A. P., Baltimore Transit Company, Baltimore, Md.
Gantt, J. S., General Electric Company, West Lynn, Mass.
Garrison, J. M., State Water Conservation Board, Helena, Mont.
Glaze, H. C., Jr., General Electric Company, Portland, Ore.
Goodell, M., Armstrong Tire and Rubber Company, Natchez, Miss.
Gostin, B. F., Tennessee Valley Authority, Wilson Dam, Ala.
Graham, D. C., General Electric Company, Pittsfield, Mass.
Guenther, F. G. H., Utah Power and Light Company, Salt Lake City.
Haley, J. L., Memphis Light and Water Division, Memphis, Tenn.
Henry, E. B. (Member), Tennessee Valley Authority, Knoxville, Tenn.
Herring, F. M., Baltimore Transit Company, Baltimore, Md.
Higgins, C. H., General Electric Company, Philadelphia, Pa.
Hill, A. J., Montana State College, Bozeman.
Hulsizer, J. E., 41 Lenox Avenue, East Orange, N. J.
Jeffrey, A. T., English Electric Company, St. Catharines, Ont., Canada.
Jeffers, L. M., Jr., Stanford University, Stanford University, Calif.
Jenner, R. R., 1737 Mississippi, Lawrence, Kans.
Johnson, M. S. (Member), Southern Bell Telephone and Telegraph Company, Atlanta, Ga.
Johnson, W. T., The Nevada-California Electric Corporation, El Centro, Calif.
Juhnke, P. B., Jr., Line Material Company, South Milwaukee, Wis.
Kallendorf, C. E., Cincinnati Gas and Electric Company, Cincinnati, Ohio.
Kaufmann, F. W., Federal Power Commission, New York, N. Y.
Kiefer, J., Aluminum Company of America, Alcoa, Tenn.
Kingsbury, C. R. (Member), Ohio Brass Company, Seattle, Wash.
Kirkwood, G. B. (Member), Pacific Electric Manufacturing Corporation, Los Angeles, Calif.
Kostic, W. B., 3250 Ludlow Street, Philadelphia, Pa.
Lautz, P. O., Atchison, Topeka and Santa Fe Railway Company, Topeka, Kans.
Long, C. E., Aluminum Company of America, Alcoa, Tenn.
Loy, J. McN., Pennsylvania Railroad Company, New York, N. Y.
Marvin, A. L., B. M. T. Corporation, Brooklyn, N. Y.
Masterson, R. C., Puget Sound Navy Yard, Bremerton, Wash.
Mazerall, E. W., Canadian Westinghouse Company, Ltd., Hamilton, Ont., Canada.
McKeon, J. B., Public Service Electric and Gas Company, Irvington, N. J.
Miller, M. L., Muzak Corporation, New York N. Y.
Miller, R. L., Public Service Company of Northern Illinois, Wheaton, Ill.
Moore, W. A., New York, New Haven and Hartford Railroad Company, New Haven, Conn.
Mueller, F. G. (Member), Commonwealth Edison Company, Chicago, Ill.
Muhleman, R. R., Atlantic Refining Company, Philadelphia, Pa.
Norman, W. H., American Telephone and Telegraph Company, New York, N. Y.
Oschwald, B., Cleveland Electric Illuminating Company, Cleveland, Ohio.
Ott, M. G., Board of Public Utilities, Kansas City Kans.
Page, R. G., Standard Oil Company, San Francisco, Calif.
Popoff, J. P. (Member), Route 1, Box 133, Cudahy, Wis.
Reid, C. R., Central Ohio Light and Power Company, Wooster, Ohio.
Row, W. E., Southern California Edison Company, Los Angeles, Calif.
Rue, H. E., The Hoover Company, North Canton, Ohio.
Schmidt, F. R., The Mountain States Telephone and Telegraph Company, El Paso, Tex.
Schuck, C. L., General Electric Company, Philadelphia, Pa.
Scott, J. A., United States Treasury Department, Washington, D. C.
Shaw, C. H. (Member), care Maurice R. Scharff, New York, N. Y.
Sherlock, H. G., Mountain States Telephone and Telegraph Company, Denver, Colo.
Simpson, J. H., National Research Council, Ottawa, Canada.
Slater, F. M., Rural Electrification Project, Bowling Green, Ky.
Steiner, W. W., Navy Yard, Mare Island, Vallejo, Calif.
Tallman, S. R., Narragansett Electric Company, Providence, R. I.
Tesar, J. J., Cleveland Electric Illuminating Company, Cleveland, Ohio.
Towers, W., Narragansett Electric Company, Westerly, R. I.
Vance, P. A., General Electric Company, Fort Wayne, Ind.
Van Kleeck, R. E., Philadelphia Electric Company, Philadelphia, Pa.
Van Wambeck, S. H., Rice Institute, Houston, Tex.
Venegas, C., 228 East Fifth Street, Chester, Pa.
Wann, W. L. (Member), University of California, San Francisco.
Webster, A. D. (Member), Orrville Municipal Utilities, Orrville, Ohio.
Welf, R. H., Ohio Power Company, Coshocton.
Williams, W. A., General Electric Company, Pittsfield, Mass.
Yearout, R. McD., Midwest Electric Co-operative, Inc., Rotan, Tex.

Total, United States and Canada—90

Elsewhere

Campos, R. S., Puerto Rico Rural Administration, Ponce, Puerto Rico.
Gantt, C. H., Standard Oil Company of New York, Caripito, Venezuela, South America.
Holtane, G. C., Lago Oil and Transport Company, Ltd., Aruba, Netherlands West Indies.
Miatt, J., Department of Road Transport and Tramways, Sydney, N. S. W., Australia.
Pickles, T., Borough of Ilford Electricity Department, Ilford, Essex, England.

Total, elsewhere—5

Addresses Wanted

A list of members whose mail has been returned by the postal authorities is given below, with the addresses as they now appear on the Institute record. Any member knowing of corrections to these addresses will kindly communicate them at once to the office of the secretary at 33 West 39th St., New York, N. Y.

Coleman, Irwin M., 581 Academy St., New York, N. Y.
Cory, Harold M., 270 Washington Ave., Albany, N. Y.
Ebert, Kenneth W., 776 N. Cass St., Milwaukee, Wis.
Ember, Theodore, 4011 Springdale Ave., Baltimore, Md.
Garvey, Fred A., Brownsville, Tenn.
Johnson, Harold M., 2604 Fenwood Road, Houston, Texas.
Johnson, James Steven, 213 Buckingham St., Hartford, Conn.
Lewis, Rodney C., 310 Garland Ave., Takoma Park, Md.
McWhorter, W. Allen, Jr., 4549 Lake Park Ave., Chicago, Ill.
Straley, Munro R., Soldier, Pa.
Strauss, Walter A., 39 West 69th St., New York, N. Y.
Van Bylevelt, J. S., 220 E. 204th St., New York N. Y.

12 Addresses Wanted

Engineering Literature

New Books in the Societies Library

Among the new books received at the Engineering Society Library, New York, recently are the following which have been selected because of their possible interest to the electrical engineer. Unless otherwise specified, books listed have been presented gratis by the publishers. The Institute assumes no responsibility for statements made in the following outlines, information for which is taken from the preface of the book in question.

PATENT TACTICS AND LAW (Revised Edition of PATENTS). By R. S. Hoar. New York, Ronald Press Company, 1939. 315 pages, 9 by 6 inches, cloth, $4.50. Contains an analysis and interpretation of enough of the patent law to enable an industrial executive or engineer to cooperate with his patent attorney. Definitions, patentability, search procedure, litigation policies and maneuvers, and the organization of a patent department are discussed in nontechnical language.

METALS. Two Volumes. By Sir H. Carpenter and J. M. Robertson. New York and London, Oxford University Press, 1939. 1,485 pages, illustrated, 10 by 6 inches, cloth, $35.00. Presents an account of the industrially important metals and alloys from the point of view of the relations between treatment, characteristics, and properties. Part one describes the characteristics of pure metals; their microstructure and crystal structure, and their behavior when subjected to the action of force. Part two is devoted to the theory of alloys. Part three deals with the mechanical properties of metals and their resistance to oxidation and corrosion. Part four discusses the influence of treatment on these characteristics and properties. Parts five and six deal specifically with the industrially important ferrous and nonferrous metals and alloys.

INTRODUCTION TO VECTOR ANALYSIS FOR PHYSICISTS AND ENGINEERS. By B. Hague. New York, Chemical Publishing Company, 1939. 118 pages, diagrams, 7 by 4 inches, cloth, $1.50. This monograph is intended to provide workers approaching the subject for the first time with an introduction to those elementary principles most used by physicists and engineers. A physical rather than a mathematical point of view is adopted in the explanations.

SPANNUNGSMESSUNG AN WERKSTÜCKEN. (Ergebnisse der Technischen Röntgenkunde, Bd. 6, edited by J. Eggert and E. Schiebold.) By E. Schiebold. Leipzig, Akademische Verlagsgesellschaft, 1938. 216 pages, illustrated, 9 by 6 inches, cloth, 18.80 rm. Discusses various questions involved in the investigation and measurement of stresses in metals by X-ray and optical methods, and outlines the use of these as practical test methods.

FINDING LIST FOR UNITED STATES PATENT, DESIGN, TRADE-MARK, REISSUE, LABEL, PRINT, AND PLANT PATENT NUMBERS. By M. Randall and E. B. Watson. Berkeley, Calif., University of California Press, 1938. 31 pages, 9 by 5 inches, paper, $0.35. This pamphlet is a handy guide to the location of any patent or trade-mark. The various series of official publications in which these have appeared are listed and the numbers of the patents, etc., in each volume are stated. A list of indexes is also included.

ELECTRODE POTENTIAL BEHAVIOUR OF CORRODING METALS IN AQUEOUS SOLUTIONS. By O. Gatty and E. C. R. Spooner. Oxford, England, Clarendon Press; New York, Oxford University Press, 1938. 504 pages, charts, etc., 9 by 6 inches, cloth, $8.00. Ten papers describing experiments. The first gives a general account of the principles underlying the theory of electrode potentials and indicates how they can be applied to individual cases. The remaining papers consider the specific behavior of mercury, silver, lead, copper, iron, antimony, cadmium, and magnesium, and deal in less detail with the behavior of several other metals.

ELECTRICAL ENGINEERING. Volume I. By W. T. Maccall. London, University Tutorial Press, 1938. 547 pages, illustrated, 9 by 6 inches, cloth, 15s. The first of two volumes, based on the author's "Continuous Current Electrical Engineering" and "Alternating Current Electrical Engineering," and intended to provide a textbook for engineering colleges.

A.S.T.M. STANDARDS ON ELECTRICAL INSULATING MATERIALS. Prepared by Committee D-9 on Electrical Insulating Materials. January 1939. Philadelphia, American Society for Testing Materials, 1939. 361 pages, illustrated, 9 by 6 inches, paper, $2.00. This pamphlet contains, in addition to the current report of the committee on electrical insulating materials, the methods for testing these materials which the society has developed. Eight standard and 19 tentative methods are described. Specifications for certain rubber and textile products and methods of testing shellac are also included.

CIRCUITS AND MACHINES IN ELECTRICAL ENGINEERING. By J. O. Kraehenbuehl and M. A. Faucett. New York, John Wiley and Sons, 1939. 691 pages, illustrated, 9 by 6 inches, cloth, $4.50. For the use of nonelectrical engineering students; both alternating and direct current are treated. The development of the theory of electrical circuits and the construction and operation of electrical machines are so presented as to enable the student to recognize and use the fundamental principles.

LOCOMOTIVE CYCLOPEDIA OF AMERICAN PRACTICE. Compiled and edited by the Association of American Railroads, Mechanical Division. Tenth edition. New York, Simmons-Boardman Publishing Corporation, 1938, 1,232 pages, illustrated, 12 by 8 inches, paper, $5.00. This edition contains improvements in arrangement and indexing, and has been thoroughly revised and brought up to date by the inclusion of new designs. The section on locomotive shops and engine terminals has been entirely rewritten.

PSYCHOLOGY FOR BUSINESS AND INDUSTRY. By H. Moore. New York and London, McGraw-Hill Book Company, 1939. 527 pages, illustrated, 9 by 6 inches, cloth, $4.00. Discusses the contribution of psychology to the solution of practical business problems. Selection of employes, testing fitness, training and promoting workers, accident prevention, fatigue, and psychological problems in advertising and selling are considered, and constructive suggestions made.

GMELINS HANDBUCH DER ANORGANISCHEN CHEMIE. System-Nummer 59: Eisen, Teil D, Magnetische und elektrische Eigenschaften der legierten Werkstoffe. Edited by Deutsche Chemische Gesellschaft. Eighth edition. Berlin, Verlag Chemie, 1936. 466 pages, illustrated, 10 by 7 inches, paper, 57.75 rm. A summary of the literature on the magnetic and electrical properties of the alloys of iron which appeared before September 1936. All the periodical literature is reviewed, with references to sources. Appended are lists of patented alloys and trade names of alloys with special properties.

A HISTORY OF SCIENCE, TECHNOLOGY, AND PHILOSOPHY IN THE EIGHTEENTH CENTURY. By A. Wolf. New York, Macmillan Company, 1939. 814 pages, illustrated, 10 by 6 inches, cloth, $8.00. In this volume Doctor Wolf continues his previous work by giving a full, profusely illustrated account of the progress made during the eighteenth century in all the sciences and in technology. Of special interest to the engineer are the descriptions of advances in the testing of materials, the development of structural, road, and canal building, power plant and machinery, mining, metallurgy, etc. The illustrations are from contemporary works.

DEPRECIATION, PRINCIPLES, AND APPLICATIONS. By E. A. Saliers. Third edition. New York, Ronald Press Company, 1939. 482 pages, charts, etc., 9 by 6 inches, cloth, $5.00. Considers business-management, operating finance, and accounting in their connection with depreciation and valuation, including actual methods of procedure. Problems are analyzed and the practical and legal aspects of various methods of treatment discussed. Appendix contains tables of probable useful life and depreciation rates for hundreds of items.

ALTERNATING-CURRENT CIRCUITS. By J. M. Bryant, J. A. Correll, and E. W. Johnson. Third edition. New York and London, McGraw-Hill Book Company, 1939. 522 pages diagrams, charts, tables, 9 by 6 inches, cloth, $4.50. The first six chapters of this revised edition discuss the theory of alternating-current circuits and the development of the equations applying to the various types of circuits. The remaining ten chapters consider the application of these principles to polyphase circuits and transmission lines. Transients and circuits containing magnetic materials are not treated in this volume. Problems accompany each chapter.

DIRECT-CURRENT MACHINERY. By H. S. Bull. New York, John Wiley and Sons, 1939. 318 pages, illustrated, 9 by 6 inches, cloth, $3.00. Topics in this textbook have been arranged for better correlation with laboratory instruction; otherwise the treatment is that customary to elementary books on the subject. A set of explanatory problems is included.

L'ÉLECTROCHIMIE ET l'ÉLECTROMETALLURGIE, two volumes. By A. Levasseur. Fourth edition, enlarged. Paris, Dunod, 1939. Diagrams, etc., 10 by 7 inches. Volume I. Électrolyse. 210 pages, paper, 52 frs.; bound, 72 frs. Volume II. Fours Électriques. 254 pages, paper, 58 frs.; bound, 78 frs. Volume I discusses electrolytic theory and the general principles of electrolysis in solutions, describes specific processes for alkalis and chlorine compounds, and treats briefly of copper refining and the electrodeposition of metals. Volume II covers the general principles, calculations, installation methods, automatic regulation, efficiency, and specific applications of electric furnaces.

ELECTROLYTIC CONDENSERS, THEIR PROPERTIES, DESIGN AND PRACTICAL USES. By P. R. Coursey. New York, John F. Rider, 1938. 172 pages, illustrated, 9 by 6 inches, cloth, $3.00. Although somewhat restricted for commercial reasons, the most recent developments in electrolytic capacitors are presented in this book. The special properties, general and specific design information, and industrial applications are discussed with reference to the wet, semi-dry, and dry types of capacitors.

FUNDAMENTALS OF ELECTRICITY AND MAGNETISM. By L. B. Loeb. Second edition. New York, John Wiley and Sons, 1938. 554 pages, diagrams, etc., 9 by 6 inches, cloth, $4.00. Intended for students who have studied elementary physics and the elements of calculus, this textbook covers the general field of electricity and magnetism, emphasizing the mathematical approach to the subject, and is planned to enable the student to apply his physics to practical engineering problems. A survey of the historical development of the subject is included. The new edition has been revised and in part rewritten.

GEORG SIMON OHM. By R. von Füchtbauer. Berlin, VDI-Verlag, 1939. 246 pages, illustrated, 9 by 6 inches, cardboard, 7.50 rm. This biography of the great electrician, by his grandnephew, appears at the sesquicentennial of his birth. It contains a comprehensive account of his ancestry, life, and achievements, based upon family records and other material. A bibliography of Ohm's publications and a list of sources are included.

POWER-FACTOR ECONOMICS. By P. L. Rogers. New York, John Wiley and Sons, 1939. 143 pages, illustrated, 9 by 6 inches, cloth $2.50. Aims to answer the questions that arise when power factor is considered and to provide simple, accurate means for solving power-factor problems. Largely devoted to industrial plants, the book includes a section on the distribution systems of public utilities.

PRACTICAL HEAT. Edited by T. Croft, revised by R. B. Purdy. Second edition. New York and London, McGraw-Hill Book Company, 1939. 726 pages, illustrated, 8 by 6 inches, cloth, $5.00. A textbook on heat which can be used by those with no mathematical equipment beyond arithmetic. Explanation of the fundamental laws of heat phenomena, the effects of heat, and the properties of vapors, is followed by sections on the practical applications of heat phenomena in steam and internal-combustion power plants, building heating, and refrigeration.

THE PRINCIPLES of ELECTROCHEMISTRY. By D. A. MacInnes. New York, Reinhold Publishing Corporation, 1939. 478 pages, diagrams, etc., 9 by 6 inches, cloth, $6.00. With the object of presenting theoretical electrochemistry as it is today, as a logical, connected whole. This textbook attempts to deduce equations from first principles, to utilize the best experimental work in deriving values for physical constants, and to cite the original literature adequately.

Engineering Societies Library

39 West 39th Street, New York, N. Y.

MAINTAINED as a public reference library of engineering and the allied sciences, this library is a co-operative activity of the national societies of civil, electrical, mechanical, and mining engineers.

Resources of the library are available also to those unable to visit it in person. Lists of references, copies or translation of articles, and similar assistance may be obtained upon written application, subject only to charges sufficient to cover the cost of the work required.

A collection of modern technical books is available to any member residing in North America at a rental rate of five cents per day per volume, plus transportation charges.

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Papers Presented at Pacific Coast Convention, Portland, Ore., August 9–12, 1938

No.	Authors	Titles of Papers (Some Shortened)
☐ 38-43	Lightning Arrester Subcom.	*Testing and Application of Lightning Arresters
☐ 38-99	Monroe	†Electrification of the San Francisco-Oakland Bay Bridge Railway
☐ 38-100	Whelchel	*Trends in Electrical Equipment in Hydraulic Power Plants
☐ 38-101	McMillan	*Polarity Limits of the Sphere Gap
☐ 38-102	Smith	*Use of Bismuth Bridge Magnetic Fluxmeter for A-C Fields
☐ 38-103	Shuck	*A Variable-Register-Ratio Watt-Hour Meter
☐ 38-104	Thomson	*Similitude of Critical Conditions in Ferroresonant Circuits
☐ 38-105	Morris	*Application of Copper-Oxide Rectifiers
☐ 38-106	Wagner	*Self-Excitation of Induction Motors
☐ 38-107	Ager	*Determination of Induction-Motor Performance
☐ 38-108	Dalziel	*Static Power Limits of Synchronous Machines
☐ 38-109	Peterson	*General Operation of Transmission Line
☐ 38-110	Cozzens & Peterson	*Corona Experience on Transmission Line
☐ 38-111	Cozzens	*Insulation and Lightning Protection
☐ 38-112	Laughlin	*Carrier-Current Equipment
☐ 38-114	Skellett	*Narrow-Band Transmission System for Animated Line Images
☐ 38-115	Norwine	*Controlling Amplitude Characteristics of Telephone Signals
☐ 38-116	Gaylord	*The Pumping System of the Colorado River Aqueduct
☐ 38-117	Skilling	*The Electrical Strength of Air at High Pressure
☐ 38-118	Pierce and Hamilton	*Phase-Angle Control of System Interconnections
☐ 38-119	Lyon	*The Electrostatic Unbalance of Transmission Lines

Papers Presented at Southern District Meeting, Miami, Fla., November 28–30, 1938

No.	Authors	Titles of Papers
☐ 38-124	Kirkwood	Grading the Engineer's Job
☐ 38-125	Almond	Electrical Design of Pickwick Landing Project
☐ 38-126	Jones	Mulsifyre System for Extinguishing Oil Fires
☐ 38-127	Housley	*Reconditioning of Insulating Oils by Activated Alumina
☐ 38-128	Stratton & Stratton	Shop Practice in the Repair of High-Voltage Bushings
☐ 38-129	George & Bessesen	*Generator Damper Windings at Wilson Dam

Papers Presented at Winter Convention, New York, N. Y., January 23–27, 1939

No.	Authors	Titles of Papers
☐ 38-122	Putman & Dann	Loading Transformers by Copper Temperature
☐ 39-4	Morgan, Brown & Schumer	Determination of Stray Load Loss in Induction Machines
☐ 39-5	Potter	Measurement of Temperature in Squirrel-Cage Induction Motors
☐ 39-6	Hellmund	The Rating of Electrical Machinery and Apparatus
☐ 39-8	Brown & Cahoon	An Amplifier-Wattmeter for Measurement of Watts and Vars
☐ 39-11	McDonald	Voltage Control of Mercury-Arc Rectifiers
☐ 39-13	Johnson	Predetermination of Temperatures in Resistance Welds
☐ 39-15	Relay Subcommittee	High-Speed Relaying Experience and Practise
☐ 39-17	Lynn	Effects of Temperature on Rotating Electrical Machinery
☐ 39-18	Rutherford	The Rating and Application of Motors for Refrigeration
☐ 39-19	AIEE & EEI Committees	*Bus Protection
☐ 39-21	Konn & Craton	*Performance of the 3600-Hp New Haven Electric Locomotives
☐ 39-22	Kotterman	The Magnesium Copper Sulphide Rectifier Battery Charger
☐ 39-23	Seletzky & Zucker	Sensitivity of the Four-Arm Bridge
☐ 39-26	Strang & Hanna	Modernization of Switch House Design
☐ 39-27	Harder	Relay Protection of Pennsylvania Railroad Electrification
☐ 39-31	Smith, Sonnemann & Dodds	Applying Ratio Differential Relays for Bus Protection
☐ 39-33	Kent & Blye	Inductive Co-ordination With Series Sodium Lighting Circuits
☐ 39-34	Ludwig & Grissinger	A New High-Capacity Air Circuit Breaker
☐ 39-35	Dickinson	"De-Ion" Air Circuit Breaker for Central-Station Service
☐ 39-39	Cox & Jones	Ignitrons for the Transportation Industry
☐ 39-40	Gray & Breyer	An Electronic Control Circuit for Resistance Welders
☐ 39-42	Cassidy & Mosteller	*Continuous Processing for Automobile Tire Fabrics
☐ 39-43	Smith	Electric Drives for Supercalenders in Paper Mills
☐ 39-45	Chu & Barrow	Electromagnetic Horn Design
☐ 39-46	Byrne	Polyphase Broadcasting
☐ 39-47	Dellinger	The Role of the Ionosphere in Radio Wave Propagation
☐ 39-52	Clarke, Crary & Peterson	Overvoltages During Power System Faults
☐ 39-53	Kendall & Affel	A 12-Channel Carrier Telephone System for Open-Wire Lines
☐ 39-54	Lawton	The Submarine Cable Plow
☐ 39-55	Nelson	The Submarine Cable Depthometer
☐ 39-56	Sorber & Smith	Remote Control Tollboard
☐ 39-57	Scudder & Reynolds	*Crossbar Dial Telephone Switching System
☐ 39-58	Corney & Edson	Modernization of L Street Station Switch House
☐ 39-59	Hildebrand	Duty Cycles and Motor Rating
☐ 39-65	Roby	Simplified Precision Resistance Welder Control
☐ 39-66	Wright	Power Supply for Single-Phase Resistance Welders
☐ 39-68	Kidder	Notes on Emergency Ratings
☐ 39-69	Thomas	Economical Loading of Underground High-Voltage Cables
☐ 39-71	Shanklin	Low Gas Pressure Cable
☐ 39-72	Lincoln & Sprole	Demand Meter Time Periods
☐ 39-73	Keinath	An Automatic A-C Potentiometer and Applications to Testing
☐ 39-74	Green	Aluminum-Nickel-Cobalt Brake Magnets for Watt-Hour Meters

* These papers have been published in the Transactions section of Electrical Engineering.
† This paper has been published in the 1938 AIEE Transactions volume.